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ABSTRACT

Groundwater is an extremely valuable resource that many feel has been too long neglected and taken for granted. There is growing recognition in Illinois and throughout the United States that comprehensive groundwater protection measures are vital. Illinois embarked on a course in protecting groundwater resources with the passage of the Illinois Groundwater Protection Act in 1987. The Interagency Coordinating Committee on Groundwater brought 10 state agencies together to solve problems related to groundwater contamination. The Department of Energy and Natural Resources' primary responsibilities under the act involve research, monitoring, technical assistance, and education. This activity guide was produced in response to groundwater legislation in Illinois and is correlated with state learning goals in biology and physical sciences. Ten activities include the water cycle, how different soils affect water movement, porosity and permeability, water filtering, water monopoly, hazardous substances, waste disposal, and decision making. Appendices include background information, activity sheets, a glossary, a list of agency resources, additional curricular resources, and a conceptual framework. (CW)

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Reprinted: February 1989

GROUNDWATER: ILLINOIS' BURIED TREASURE
EDUCATION ACTIVITY GUIDE

Prepared by:

The Environmental Education Association of Illinois

Project Director:
Mary Kelly Lamb

Coordinated through:

The Museum of the
Chicago Academy of Science

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Springfield, IL 62704-1892

James R. Thompson, Governor
State of Illinois

Karen Witter, Director
Illinois Department of
Energy and Natural Resources

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James R. Thompson, Governor
State of Illinois

Don Etchison, Director
Illinois Department of
Energy and Natural Resources

September 1, 1988

Dear Educator:

Groundwater is an extremely valuable resource that has been too long neglected and taken for granted. There is growing recognition here in Illinois and throughout the nation that comprehensive groundwater protection measures are vital.

Illinois embarked on an important new course in protecting our groundwater resources with the passage of the Illinois Groundwater Protection Act in 1987. The Interagency Coordinating Committee on Groundwater brings 10 state agencies together to solve problems related to groundwater contamination. The Department of Energy and Natural Resources' (ENR) primary responsibilities under the act involve research, monitoring, technical assistance, and education.

Your interest and participation in the Groundwater Education Project initiated by the Environmental Education Association of Illinois are greatly appreciated. This department is pleased to present **Groundwater: Illinois' Buried Treasure**, an education activity guide for grades kindergarten through 12. I hope that you will take full advantage of the resources available from ENR and other state and local agencies.

The processes used to study and manage groundwater resources are often neglected in resource education. The educational activities included in this book are designed to help students understand the importance of groundwater management, as well as specific facts and principles of groundwater.

The challenge is before you to combine your skills, dedication, and creativity with these and other materials to teach the next generation of Illinois citizens to improve on this generation's management of our invaluable hidden resource--groundwater.

Sincerely,

Don Etchison

Don Etchison
Director

Preface

Groundwater: Illinois' Buried Treasure is a supplementary environmental education activity guide emphasizing groundwater in Illinois.

Almost half of Illinois residents rely on groundwater to meet their daily needs. Recognizing the importance and vulnerability of this water supply, the State of Illinois enacted the Illinois Groundwater Protection Act (IGPA) in September, 1987 to ensure the protection of this invaluable resource.

The activity guide is a response to IGPA to provide educational materials which elementary and high school teachers can use to prepare our citizens of tomorrow to care for Illinois' precious groundwater. Each activity is correlated with the Illinois State Goals and Knowledges/Skills for Learning in the Biological and Physical Sciences for easy incorporation into the classroom.

Groundwater: Illinois' Buried Treasure is a joint project of the Illinois Department of Energy and Natural Resources and the Environmental Education Association of Illinois, and coordinated through The Museum of The Chicago Academy of Sciences.

The Environmental Education Association of Illinois (EEAI) is a not-for-profit organization comprised of concerned citizens who are interested in educating people of all ages about the importance of our environment. EEAI is the only organization in Illinois that makes environmental literacy its primary goal.

The Museum of The Chicago Academy of Sciences, the country's second oldest scientific institution, is dedicated to promoting science literacy and developing an interest in science through increased awareness of nature. Its exhibits, education programs, and research emphasize the natural history of the Great Lakes region.

This groundwater activity guide would not exist, however, were it not for the input and support of enthusiastic, dedicated educators, school administrators, and state agencies whose combined efforts have created the first environmental education materials specific to Illinois.

Evaluation

All comments and critiques regarding *Groundwater: Illinois' Buried Treasure* are welcome and encouraged. An evaluation form can be found on page 57. Please send comments to Illinois Department of Energy and Natural Resources, Groundwater Education, 325 W. Adams, Springfield, IL 62704-1892.

Acknowledgements

Groundwater: Illinois' Buried Treasure would not be possible were it not for the many individuals and state agencies who lent their expertise, experience, and enthusiastic, continuing support to the project. We would like to take this opportunity to express our thanks and appreciation to everyone who has assisted in this environmental education endeavor. It is not possible to individually thank the several hundred students who participated in the pilot testing of these activities but we are certainly no less appreciative of their invaluable feedback.

Project Director Mary Kelly Lamb

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TABLE OF CONTENTS

ACTIVITIES

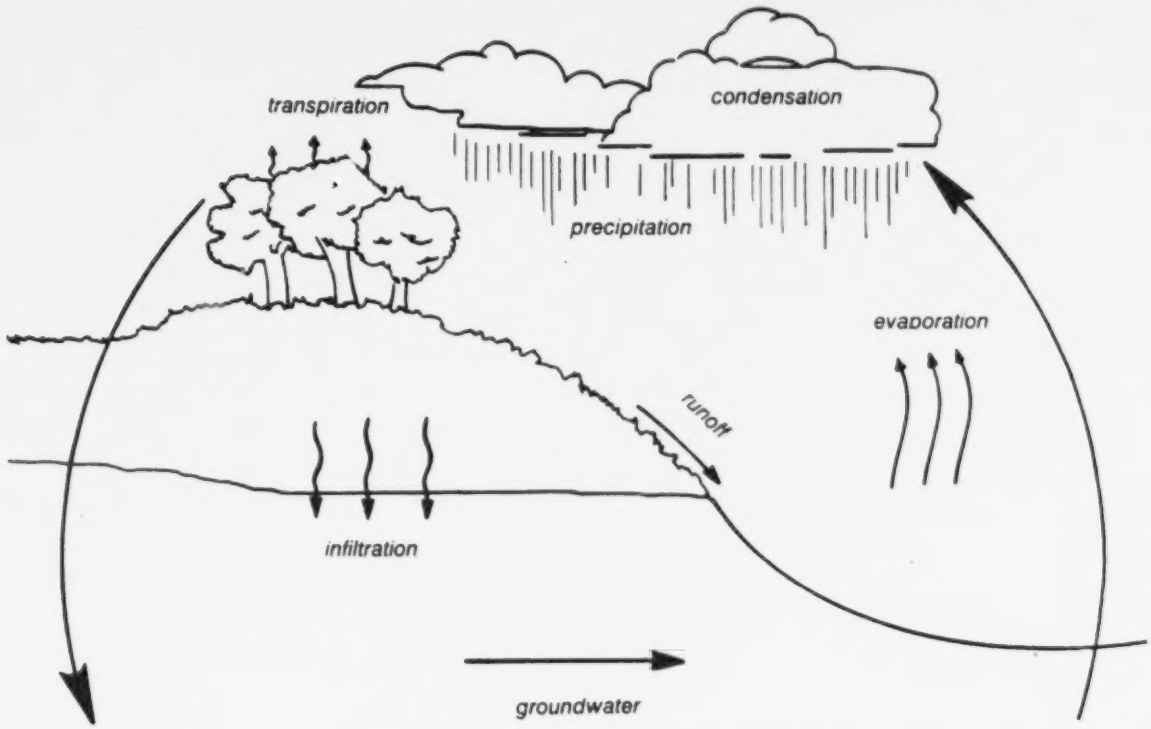
Nature's Water Cycle 1
How Different Soils Affect the Movement of Water 5
Porosity and Permeability 8
Purifying Water by Filtering 11
Water Monopoly 13
Where Does It Go When You Flush? 15
Hazardous Homework 18
Big City Blues 21
Disposal Under Management Policy: D.U.M.P. 25
Decision-Making Simulation 28

APPENDICES

Graphic Activity Sheets 35-38
Interesting Facts About Illinois Groundwater 39
Illinois Groundwater: Myths and Facts 40
Major Users of Groundwater in Illinois 41
The Human Impact on Groundwater 42
U.S. Residential Water Use 43
World Water 44
Drinking Water Treatment Process 45
Septic Tanks and Drain Fields 46

GLOSSARY 47
GROUNDWATER RESOURCES 51
CONCEPTUAL FRAMEWORK 56
EVALUATION FORM 57

NATURE'S WATER CYCLE



Objective

Students will be able to understand the hydrologic cycle and the role evaporation plays in it.

Method

Students conduct a simple experiment with water to observe evaporation and condensation.

Background

Hydrology is the study of the movement and distribution of the waters of the earth. In nature, water circulates through a system called the water cycle or hydrologic cycle. Heat from the sun causes ocean water to evaporate and become water vapor. The atmosphere holds the water vapor in the form of an invisible gas. When the temperature of the air cools, the water vapor condenses to form droplets that are visible as clouds, steam or fog. When there is enough cooling, the droplets become large enough to fall back to the earth as rain, hail, sleet or snow. Rain that falls directly on the oceans completes the cycle and returns to its source, but rain that falls on the land may soak through the soil and become part of the groundwater.

The two main sources of fresh water are: 1) surface water and 2) groundwater.

Surface water includes all the lakes, rivers and streams that flow over the land surface. Small streams flow into rivers, which join larger rivers that eventually return the surface water to the oceans from which it originally evaporated.

Age: Grades 2 - 6
Subject: Mathematics, Science
Skills: analysis, description, discussion, inference, observation
Duration: 20 - 45 minutes, several 5 - 10 minute periods over a few days to check water level in jars
Group Size: any
Setting: indoors
Conceptual Framework: I.A., I.B., I.D.
Key Vocabulary: condensation, cycle, evaporation, groundwater, hydrologic cycle, infiltration, precipitation
Illinois State Goals and Knowledges/Skills for Learning in the Biological and Physical Sciences: Goal 1-C,F,I,J,L, Goal 2-B, Goal 3-3, Goal 4- A,D,E,F,G,J,L

Groundwater is beneath the surface of the earth and fills the cracks, crevices and tiny pores between soil or rock particles. It is water that flows into wells drilled into the ground, or that flows out of the ground in springs. About one-half of all the people in the United States get their drinking water from groundwater. In Illinois, almost all of the people (98%) who live in rural areas get their drinking water from wells drilled into the soil and rock to collect groundwater. Also see "The Human Role in the Hydrologic Cycle" in the appendix.

Materials

Hydrologic cycle activity sheet, pan of very hot tap water (or boiling), pan of ice cubes, 4 wide mouth jars (no lids), marking pen, ruler.

Procedure

1) Demonstrate evaporation and condensation: hold the pan of ice cubes over the pan of hot (or boiling) water. The steam from the hot water condenses when it hits the cold pan. The condensed water (watch for beads formulating on the bottom of the ice cube pan) falls back into the pan holding the hot water to be changed to steam again, completing the cycle.

2) Give students a copy of "Nature's Waterwheel" activity sheet and repeat the demonstration with the students completing the sheet.

3) Take each jar and mark a black line two inches from the bottom on each one. Number jars. Fill each jar with water to the black line. Place jars, without lids, throughout the room such as: window sill, coat closet, top of bookcase, and in front of room on a table. Students predict which jar of water will evaporate first. Check every day until one jar of water has evaporated. Discuss what factors affected the rate of evaporation in each jar. Note factors influencing evaporation rate such as: a) room temperature; b) furnace or air conditioning operation; c) drafts from open windows; and d) direct sun light heating and evaporating the water.

NOTE: Remind students the sun is the natural source of heat. This experiment demonstrates the effects of the sun's heat (evaporation) and the effects of cooling temperatures (condensation).

For Upper Grades have students graph the daily water levels. Teachers should stress the importance of taking and recording accurate results. Use metric measurements or convert numbers into metric.

4) Repeat the procedure to verify results.

Evaluation

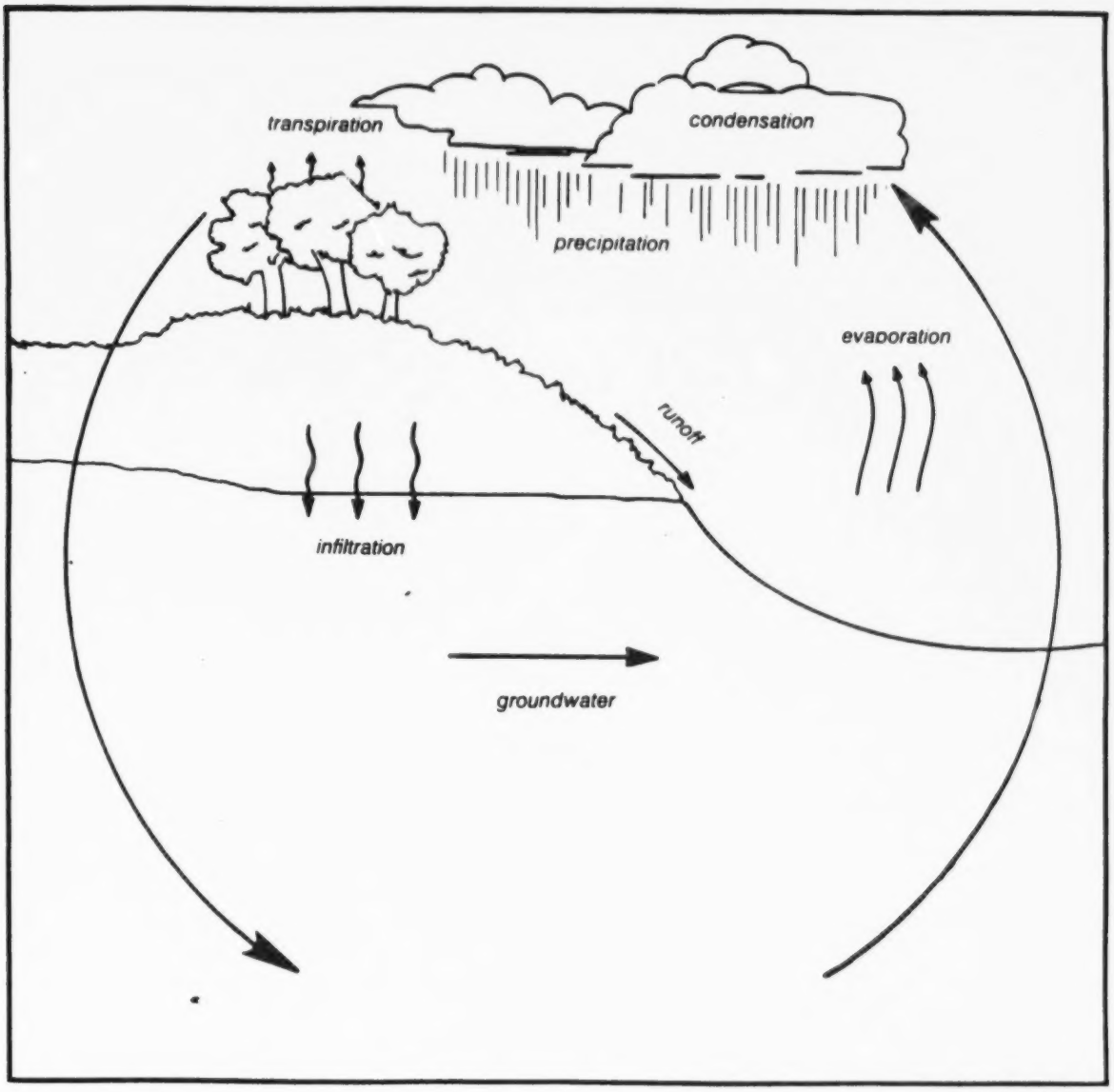
Describe the physical changes that happen to water when it is heated; when it is cooled.

Extensions

1. Construct a classroom terrarium to illustrate a miniature water cycle: In the bottom of the fishbowl or aquarium (any size), lay down a one inch layer of gravel, followed by peat moss and soil. Place a variety of plants in the aquarium, water lightly, cover with plate glass, and place in a sunny warm place. If the cover fits tightly students should observe no additional water needs to be added. Discuss that the water evaporating from the soil and transpiring from the plants condenses and returns to the soil.

2. Continue studying the movement of water into groundwater, see "How Different Soils Affect the Movement of Water" activity.

Nature's Waterwheel - Answer Sheet

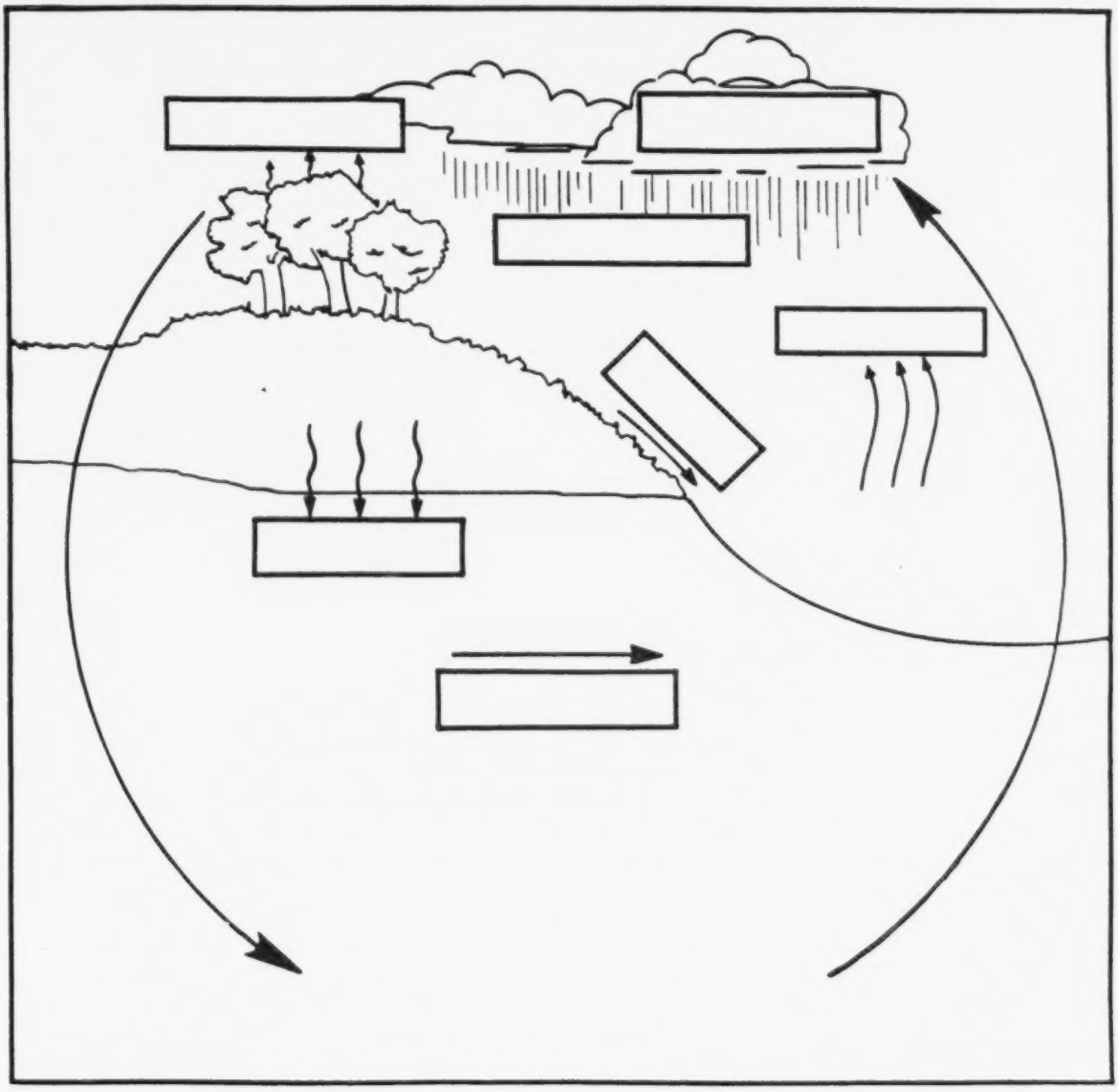


IEPA GRAPHIC

Hydrologic Cycle

Think about the water on the ground. The water on the ground evaporates when the ground gets warm. Think about the warm air rising. The air and water vapor expand and rise high. The air is cooled when it rises. When the air is cooled, the water vapor condenses. The water vapor condenses to make clouds. Cloud and fog drops come together to make bigger water drops. The bigger drops are rain, snow or hail which fall on the ground. The water evaporates again. The whole cycle starts again. Water vapor condenses. Rain falls to the ground. This is the water cycle or hydrologic cycle.

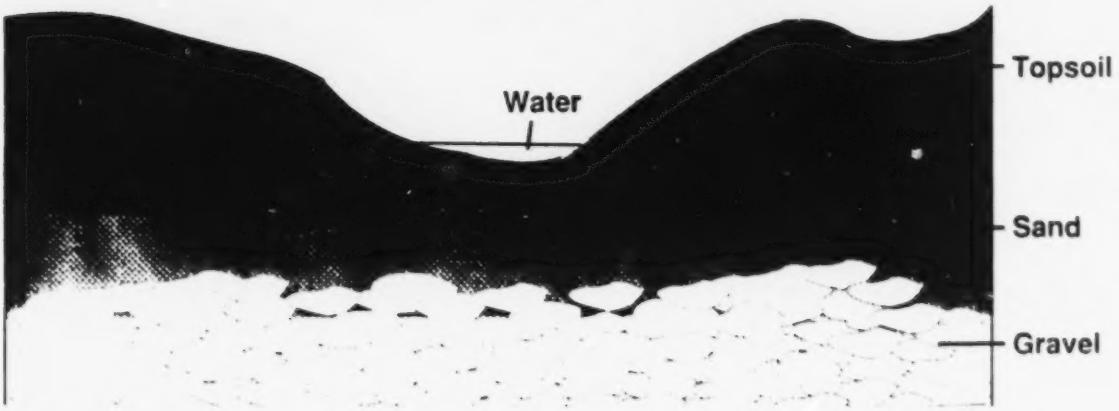
Nature's Waterwheel - Student Activity Sheet



Hydrologic Cycle

Condensation - The changing of water vapor to liquid.
Evaporation - The changing of water into water vapor.
Groundwater - Water found below the surface of the earth.
Hydrologic Cycle - Process involving the circulation and distribution of water on the earth.
Infiltration - The process by which water seeps into the soil.
Precipitation - Forms of condensed water vapor that are heavy enough to fall to the earth's surface such as rain, snow, sleet, hail and fog.
Runoff - Water that drains or flows off the surface of the land.
Transpiration - The process in which water vapor is released into the atmosphere through plants.

HOW DIFFERENT SOILS AFFECT THE MOVEMENT OF WATER



Objectives

Students will be able to 1) measure soil volume accurately; 2) identify three types of soil by texture; and 3) make visual observations about water movement through the soil.

Method

Students predict the rate of water percolation through different soils and conduct a simple experiment to verify predictions.

Background

Water that seeps downward into the zone of saturation (area under ground in which every available space is filled with water) through the soil is called groundwater. The size of the soil particle, or grain, determines the rate at which water can pass through, or percolate. The larger the particle size, the more air space between particles for water to flow. The smaller the particle size, the less air space. Consequently, less water can pass through during the same amount of time which decreases the percolation rate.

EXAMPLE: A soil high in coarse grained material, such as sand, allows the water to travel through faster than a fine material, such as clay. The addition of topsoil, which generally contains clay, slows down water percolation due to the very small (less than 0.01 millimeters) particle size of clay. Also see background for "Porosity and Permeability" activity.

Age: Grades 2 - 9
Subject: Science, Math
Skills: Measurement, prediction, comparison, application, observation, estimation, experimentation.
Duration: Two 45 minute periods
Group Size: Any
Setting: Indoors, outdoors
Key Vocabulary: absorb, gravel, percolation, groundwater, permeable, prediction, sand, topsoil, zone of saturation.
Conceptual Framework: IA, ID, IID, IIE, IIF
Illinois State Goals and Knowledges/Skills for Learning in the Biological and Physical Sciences: GOAL 1-C,I; GOAL 2- B,C,G,H,F; GOAL 3-A,B1,B3 and B4; GOAL 4-A,D,E,F,G,H,I, L,J,M.

Reference

Focus on Earth Science, Teachers Resource Manual, by Charles E. Merrill Publishing Company, Copyright 1984.

Materials

Three large paper cups, sand, top soil, gravel, 3 plastic coffee can lids, 3 squares cheesecloth or nylon stockings, rubber bands, pencil, water, four 250 ml beakers, thumbtack, scissors, stopwatch

Procedure

1) Using the thumbtack, punch several holes in the bottom and around the lower part of each cup. Make sure you punch the same number of holes in each cup.

2) Place a square of cheesecloth or nylon stocking over the bottom of each cup so it covers all the holes. Secure the cheesecloth with a rubberband.

3) Using scissors, cut a hole in the plastic coffee can lid so that the cup just fits inside. Place each cup in a lid, and place each lid over a beaker. Label the cups A, B, and C.

4) Fill Cup A half full of dry sand, Cup B half full of top soil, and Cup C half full of a mixture of sand, gravel and top soil.

5) Predict which soil will allow the water to percolate through the fastest and the time it will take. (Sand and gravel will have the fastest rates of percolation, less than a minute).

6) Pour 100 ml of water into each cup. Record the time when the water was first poured into each cup.

7) Record the time when the water first drips from each cup. Note the appearance of the water.

8) Allow the water to drip for 25 minutes. At the end of this time, remove the cups from the beakers. Measure and record the amount of water in each beaker.

9) Make a chart on a chalk board or poster paper. Fill it out with students supplying the data.

10) Compare results and discuss: - Which soil sample has the fastest rate of percolation? The slowest? - Which sample is most permeable? The least? - How does the addition of gravel affect the permeability of top soil? - How does soil type affect the movement of ground- water? - Can soil type protect groundwater? Which one? How?

TIME

CUP	WATER IN	WATER OUT	OBSERVATIONS
A			
B			
C			

Evaluation

Indicate which of the following is true (T) or false (F).

1) Groundwater is that water which is found at the surface;

2) Water percolates through different soils at different rates;

3) Clay allows water to percolate through quickly; and

4) Sand is the least permeable soil.

Extensions

1) Discuss what happens to the rate of percolation if soil is compacted.

Experiment:

a) Pick two outdoor contrasting areas to study - one covered with grass, one of compacted soil.

b) At each site: drive a 32 oz. tin can (both ends removed) equal lengths into the soil (at least 2 inches). Pour 2 cups of water into each can and record the time it takes for the water to percolate through the soils.

c) Compare the results: which area absorbed the water faster? Why? If the water is not absorbed into the soil, where does it go?

d) Discuss: If you were to select a garden plot, where would be the best place? Why?

2) Convert data chart into a simple bar graph.

3) Do "Porosity and Permeability" activity.

POROSITY AND PERMEABILITY

Objective

Students will be able to describe some characteristics of clay, sand, and gravel in relation to groundwater.

Method

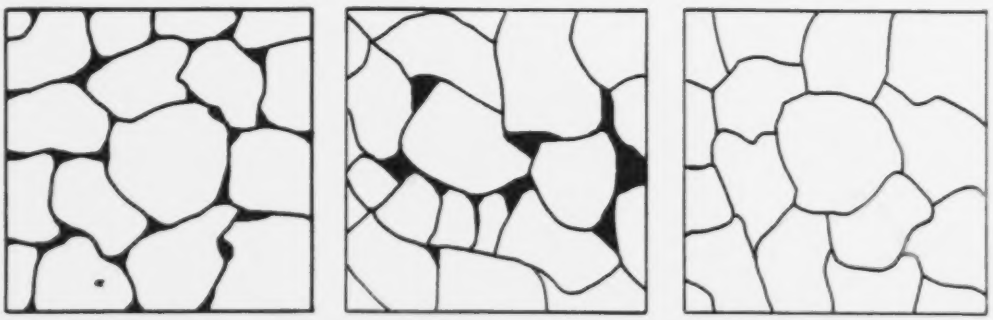
Students conduct simple experiments to measure pore space and permeability of three types of unconsolidated materials and compare results.

Background

The porosity of a rock or rock material tells you how much of its volume is open space or air. The permeability of a rock is its ability to transmit water or other liquids. Both porosity and permeability are important in relation to groundwater because it determines how quickly and how much water moves through and into an aquifer.

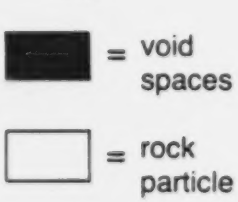
Reference

Earth Science Activities to accompany Earth Science, Samuel N. Namowitz, D.C. Heath and Company, 1981, pp 25-28. Also see background for "How Different Soils Affect the Movement of Water" activity.



a. High porosity b. Moderate porosity c. Extremely low porosity

SWS Graphic



Age: Grades 7 - 12
Subject: Mathematics, Science
Skills: analysis, computation, experimentation, inference, measurement
Duration: 30 - 45 minutes
Group Size: any
Setting: Indoors
Conceptual Framework: I.D., II.D, II.E.
Key Vocabulary: clay, gravel, organic matter, permeability, porosity, unconsolidated materials
Illinois State Goals and Knowledges/Skills for Learning in the Biological and Physical Sciences: GOAL 1-I; GOAL 2-B, F; GOAL 3 - B1, B3, B4; GOAL 4 A, E, G, J, M

Materials

Gravel, sand, dry clay, funnel, filter paper, glass-marking crayon, graduated cylinder, small test tubes, test-tube rack, gas bottles, holder for funnel (ring stand and ring, or tripod), stopwatch.

Procedure

1. To measure pore space in gravel, sand, and clay: With a soft crayon or piece of scotch tape, place a mark about halfway up the sides of a small bottle, beaker, or test tube. Fill the bottle to the mark with water, and then measure the volume of water in a graduated cylinder. This is the volume of that part of the bottle. Record in the "Total Volume" column of the table. Dry the bottle.

a) Now fill the bottle up to the mark with gravel. Fill the graduated cylinder to its top mark with water. Slowly and carefully, pour water into the gravel until the water just reaches the top of the gravel. Note the volume of water used to saturate (fill the pores of) the gravel. Record it in the table under "Pore Space." Divide this by the total volume to compute the percentage of pore space in your sample of gravel.

MATERIAL	PORE SPACE	÷ TOTAL VOLUME	=	% PORE SPACE
Gravel				
Sand				
Clay				

2) To measure permeability of gravel, sand, and clay: Fold a circular filter paper into quarters, open it into a cone, and insert it into a small funnel.

a) Fill the cone with gravel to about half an inch from its top. Place the stem of the funnel just inside a small test tube or small glass bottle. Note how many seconds it takes to fill the test tube or glass bottle with water by pouring water through the gravel. This can be done either with a watch or by careful counting.

b) Repeat the experiment with sand and record your results.

c) Repeat the experiment with clay and record your results.

d) What happens? Compare the permeability of your samples.

Evaluation

Describe what effects particle size has on groundwater. Which would you recommend as the best unconsolidated material to protect groundwater against contamination?

Extension

1) Add humus (organic matter) to the unconsolidated material and repeat the experiment.

2) Mix sand, gravel and clay together in equal proportions and repeat the experiment.

MATERIAL	NUMBER OF SECONDS
Gravel	
Sand	
Clay	

PURIFYING WATER BY FILTERING

Objective

Students will be able to understand how filtration can purify water.

Method

Students conduct an experiment to observe how sand purifies water.

Background

Soil is a natural filter. Gross water impurities are deposited on sand particles as the water passes through the soil. This is one of the processes that purifies groundwater naturally and is used by many cities to remove sediment as a water treatment process. This process does not, however, remove minerals or bacteria. Further water treatment processes occur before it is considered, by law, safe drinking water. Also see "Drinking Water Treatment Process" in appendix.

Reference

Science for the Elementary School, 3rd Edition, MacMillan Publishing Company, Inc., Edward Victor, ed.

Materials

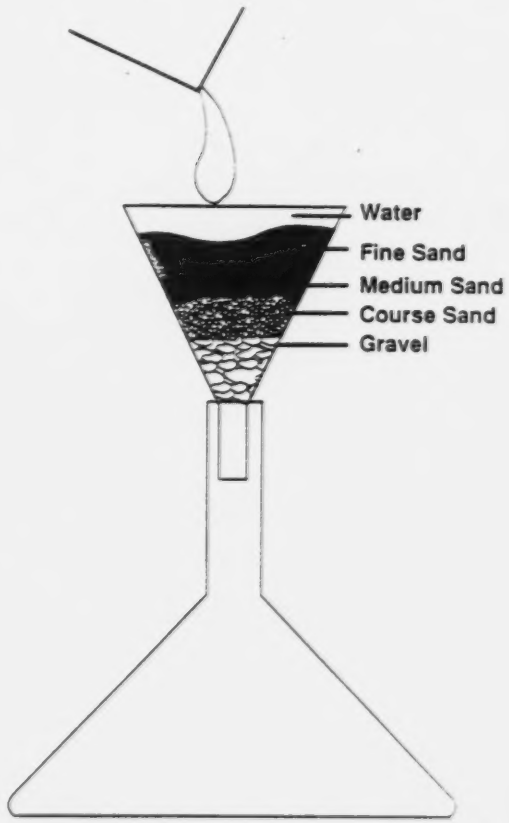
1 large funnel, fine sand, medium sand, coarse sand, gravel, clean water, muddy water, narrow-mouth glass jar.

Procedure

1) In a large funnel, place a layer of gravel pebbles, then a layer of coarse sand, a layer of medium sand, and a layer of fine sand on top.

2) Pour some clean water through the funnel to allow the layers to settle and pack together.

3) Place the funnel in a narrow-mouth glass jar and pour some muddy water into the funnel. What happens? Why?



Age: grades 3-5
Skills: analysis, discussion, experimentation, inference, observation
Duration: 30-45 minutes
Group Size: any
Setting: indoors
Conceptual Framework: I.D., II.D., II.E., IV.D
Key Vocabulary: filtration, purification, water treatment
Illinois State Goals and **Knowledges/Skills for Learning in the Biological and Physical Sciences:** GOAL 1-I; GOAL 2-B, F, G; GOAL 3-B1, 3, 4; GOAL 4-A, J, M

Evaluation

Describe how sand can purify water.

Extensions

1) Visit a water treatment plant, or invite a water treatment engineer to visit the class.

2) Compare filtration to other water treatment processes used by municipalities.

WATER MONOPOLY

Objectives

Students will be able to 1) develop an understanding of the need for water conservation; 2) understand the various amounts of water used when performing daily activities; 3) recognize weather conditions and climate as factors affecting groundwater supply; 4) categorize the effects of weather on the groundwater supply; and 5) discover ways in which they, as individuals, can positively affect the groundwater supply.

Method

Students play a game exposing them to gains and losses in their groundwater supply through daily activities and various weather conditions.

Background

Groundwater supplies are affected through usage, precipitation and contamination occurrences. The average American uses 60 gallons of water in the house each day. That does not include car washing, lawn watering, and other outdoor uses. Flushing, bathing and laundering are the largest in-house uses.

Water saved is money saved because you'll use less water and therefore pay for less. As an added bonus, when you use less hot water, your fuel bills may go down as well. Even if you are on well water, saving water reduces electric costs of pump operation and also reduces the amount of waste going to septic tanks. The water supply is also affected by weather conditions. About ten percent of precipitation percolates into the ground. The other 90% is lost to evaporation, transpiration and runoff. Therefore, rainfall and snows will slightly increase the supply. However, droughts and windstorms can decrease the supply. In addition, contamination of the supply decreases availability of some groundwater. This contamination can be the result of many sources including tank leaks, feedlot and fertilizer runoff, and road salt. Also see "Interesting Facts about Illinois Groundwater" and "How Much Does it Take" in appendix.

Materials

Water Monopoly gameboard, (back pocket) water container, markers (player pieces), Monopoly money or other numerical tokens to represent gallons, deficit cards, surplus cards, pair of dice, property cards (NOTE: Students may wish to make their own game board).

Procedure

1) Object of the game: each student or team works to be the more successful in being good stewards of water usage. The better steward is the person or team holding the most gallons of water at the end of the game.

Age: Grades 3 - 6
Subject: Science, mathematics, language arts
Skills: computation, inference, reading
Duration: 35 - 45 minutes
Group Size: 2 or 4 players
Setting: indoors
Conceptual Framework: I.A., I.B., I.C., II.A, IV.B1, IV.B2., VII.B.
Key Vocabulary: conservation, contamination, deficit, evaporation, irrigation, precipitation, transpiration, surplus
Illinois State Goals and Knowledges/Skills for Learning in the Biological and Physical Sciences: Goal 1-D; Goal 2- B,D,E,G

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2) Students draw from the four property cards. Each player or team draws an equivalent portion of the property. The person or team then owns that property and will be paid by others landing on their space on the board.

3) Each person begins the game with 600 gallons of water. All additional gallons are placed into the Water Bank.

4) Play begins with each player rolling the dice. The player with the highest total starts. His/her marker is put on the "GO" space. Both dice are rolled and the player moves in the direction of the arrow, that number of spaces. Directions are followed on the space on which the player lands. The person on the left goes next. Markers may share the same space.

5) Follow the rules of monopoly with the following exceptions: money is equal to gallons; at the beginning of the game, each player or team owns equivalent portions of the property.

Evaluation

Identify and describe three influencing factors on groundwater availability. Recommend four ways in which water can be conserved. What activity of yours requires the most water per year.

Extensions

1) Monitor water use at home.
2) Make up your own surplus and deficit cards. Use information found in the appendix.

WHERE DOES IT GO WHEN YOU FLUSH?

Objectives

Students will be able to 1) recognize where water in our homes comes from; 2) become aware of water usage choices; and 3) recognize where used water goes when it leaves our home, and how it may affect groundwater.

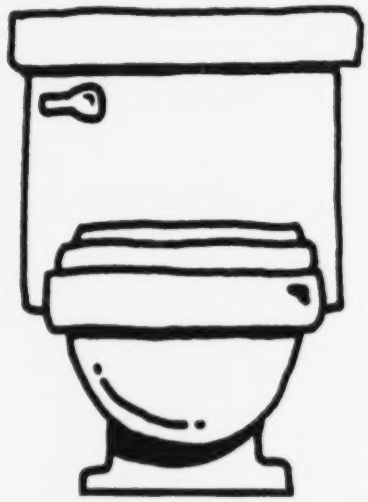
Method

Students discuss choices in water uses at home, where water comes from and where it goes, and visit a water treatment plant or invite an appropriate speaker to the classroom.

Background

See "Nature's Water Cycle" activity on the hydrologic cycle. All water is part of the hydrologic cycle and is recycled in some form or the other. However many people believe once water is flushed down a toilet, or poured down a kitchen sink it just goes "away." Houses are like mini-water cycles in that clean water entering a home on one end is used and cycled back to the system through a sewer system to be treated for purification before it can be used again.

People rely on fresh water for many things such as drinking and bathing, and it is essential for life itself. The quality of water is therefore very important. Many municipalities, state and federal agencies treat and monitor the quality of groundwater and surface water needed to keep the United States supplied with safe drinking water. Also see "Drinking Water Treatment Process," "Septic Tanks and Drain Fields", and "How Much Does it Take" in the appendix.



Materials

Large display of hydrologic cycle for review, drawing paper, mural butcher paper, colored markers, crayons, tape, glue, etc.

Procedure

1) Review hydrologic cycle.

Age: Grades 3 - 12
Subject: Art, Language Arts, Science, Social Studies
Skills: application, awareness, computation, discussion, drawing
Duration: Two 30 minute periods, minimum 45 minute period for drawing and session for field trip or speaker.
Group Size: any
Setting: indoors
Conceptual Framework: I A, B; III A; IV C
Key Vocabulary: attitudes, hydrologic cycle, recycling, water treatment
Illinois State Goals and Knowledges/Skills for Learning in the Biological and Physical Sciences: Goal 2 - K S B, F, G, H

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2) Brainstorm uses of water with the students and list on the board. Rank the uses in order of importance. Have the students decide the reasons for the choices they made. Was it difficult to decide? Would they do it differently if they really had personal choices to make about a limited supply? Which of the uses they listed are for survival? (Break into smaller discussion groups if the class is too large, compare results between groups.)

3) At home, have each student find all faucets and drains for water in the house, garage, and yard.

If possible, also find one storm sewer drain that drains any runoff from exterior water uses and main water shut off valve.

4) At home or in the classroom, have each student diagram a simple cross section of their home and indicate the location of the faucets and drains they found.

5) To complete the diagram, plan a field trip to a local water treatment plant or invite a speaker to visit the classroom to find out where the water goes when it leaves the house. Contact your local municipal officials, sanitary district, state or county health department. Also contact the Speaker Bureau, see "Resources." If tours or speakers are not possible, information about this can be obtained from these same sources.

Students should find answers to: 1) Where does our water come from (out of the faucet)?

2) After the water leaves the water treatment site, where does it go?

6) After the field trip or speaker - put each student's diagram along the top edge of the butcher paper. Add the information about where water goes and where it's coming from (color coding will help). If any water leaving the house can come back in, add it to the diagram.

Evaluation

1) Write a story on the journey of a water drop beginning with a drain in your home. Include the trip through the water treatment system, the hydrologic cycle, back into the water supply, and back into your home.

2) We say "flush it away." Where is "away" - explain cycles.

Extension

Compare the student's water system to other community systems (water treatment plant versus a septic tank). What are the similarities? What are the differences?

From Sink to Stream:

Following the Wastewater Treatment Process

1 Indoor pipes carry wastewater from the drains to underground sanitary sewer pipes. The water then goes to a sewage treatment plant.

2 Runoff from roofs, ground and streets goes into a street drain that leads to a storm sewer which empties into nearby waterways.

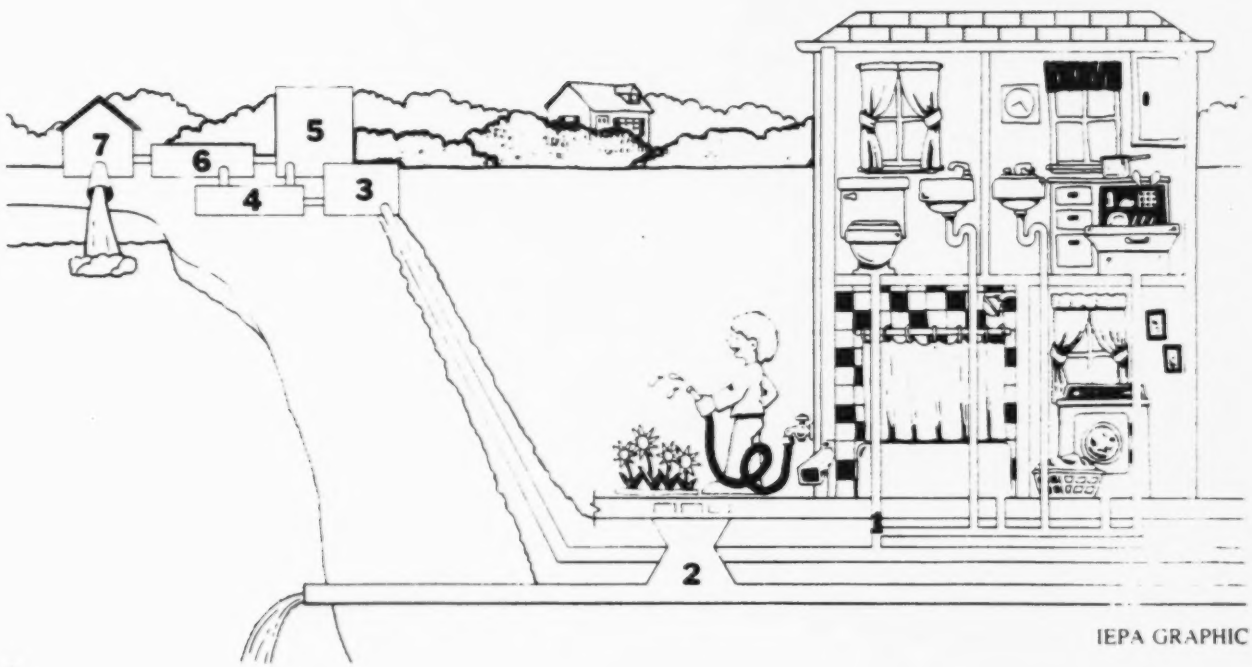
3 Wastewater travels into the screening house where all the large waste particles are trapped.

4 The water then goes to a sedimentation tank where grit and gravel sink to the bottom.

5 In secondary treatment, the water is pumped into an aeration tank where it is mixed with air for several hours.

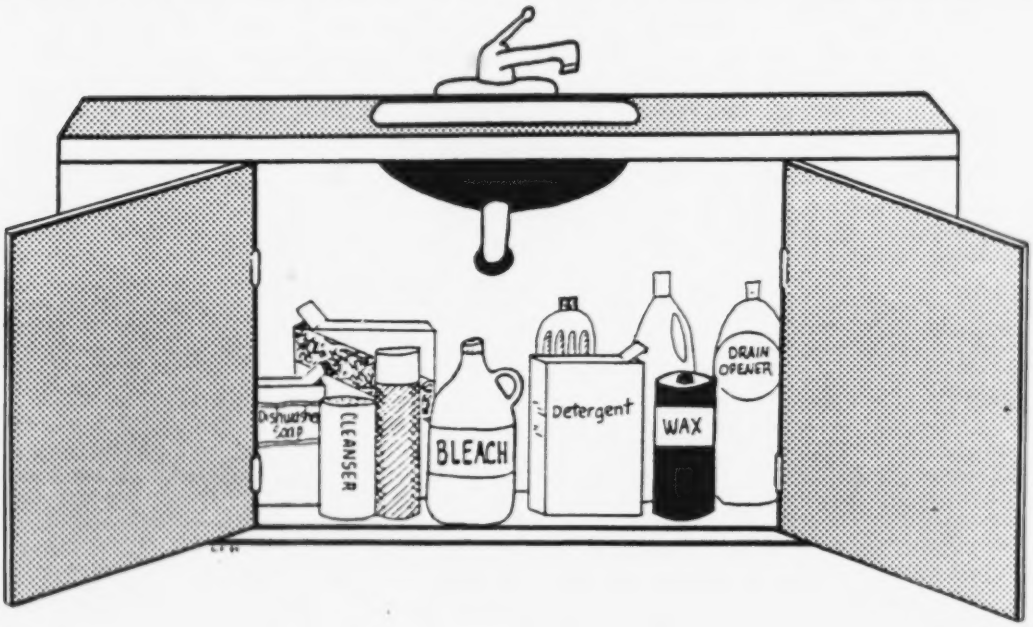
6 The water goes to a second sedimentation tank to settle the sludge. Sludge is particles of solid waste left after treatment.

7 Chlorine gas is then pumped into the water. The chlorine kills germs that cause disease. Treated water is then released to the waterway.



IEPA GRAPHIC

HAZARDOUS HOMEWORK



Objective

Students will investigate, develop, and practice responsible water quality protection habits.

Method

Students identify potential groundwater contaminants or chemicals in their homes that are harmful to people and determine proper use and disposal of these products and possible safer substitutes they could use. Students graph the results of their attempt to change habits of waste disposal and use of chemicals at home.

Background

Refer to: Chemical Hazards in the Home and Chemical Hazards in the Garage and Workshop posters. Many of the products used in our homes contain chemicals that can contribute to contamination of air in our homes and/or ground and surface water after disposal.

Materials

Magazines, mural paper, markers and crayons, glue or tape, charts of Chemical Hazards in the Garage and Workshop (one per student), (in back pocket of binder), graph paper or large chart.

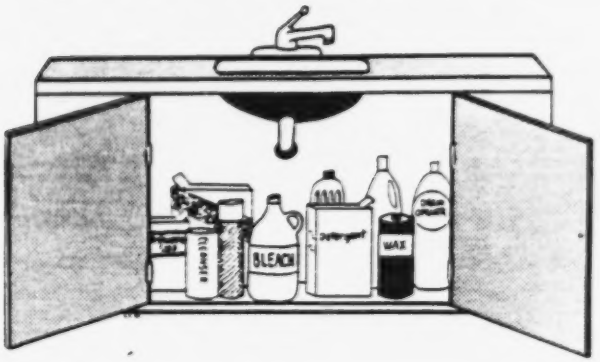
Age: 4 - 8
Subject: Art, Environmental Problems, Mathematics, Science
Skills: comparisons, discussion, evaluation, identification, listing, media construction (making and using simple bar graphs), reporting, small group work, writing
Duration: Two 45 minute periods, periodic update, short discussions and data recording
Group Size: any
Setting: indoors
Conceptual Framework: IV.B., IV.C., IV.E., VII.B.1
Key Vocabulary: attitudes, chemical waste, contaminant, groundwater, hazardous waste, influence, toxic
Illinois State Goals and Knowledges/Skills for Learning the Biological and Physical Sciences: Goal 2-C,E,F,G,H; Goal 3-A,B; Goal 4-F,G

Procedures

1) Discuss with students the fact that many products we use in our homes everyday contain potentially harmful chemicals and the importance of following label directions.

2) Assign students to look through magazines and cut out at least five household products they think may contain hazardous chemicals. They may also want to choose products they think may not be hazardous.

3) Select products from the two lists of chemical hazards and prepare a section of butcher paper for display. Have students divide the mural into sections and label the top of each section with the type of product (Ex. aerosol, detergent, disinfectant, etc...). Alternative: separate lists on posterboard or newsprint.



4) Distribute Chemical Hazards charts to students. Have students categorize the ads they have collected according to product type, and glue or tape the pictures they have collected in the appropriate columns on the mural.

5) Below each of the pictures, fill-in information available from the Chemical Hazards chart on the product's possible hazards, disposal suggestions, precautions, and substitutes. They may illustrate these sections if desired.

6) Allow students time to inspect mural or posters.

7) Have each student choose a product that they use at home. For one month (NOTE: teacher may select other appropriate period of time. Also, you may want to send a note home advising parents of the activity.) the student will try to influence a positive change in his or her family's use of the product. This change may be a demonstration of proper disposal and precautions or finding substitutes for these products. Discuss that some habits may be easy to change, others more difficult. Have students predict changes in his/her family's product use.

8) Have each student prepare an index card with the following information:

- name of chosen product
- possible hazards
- disposal suggestions
- precautions
- substitutes

Students should discuss the information with their family. Post the card near the product as a reminder to the family.

9) After the month is up, conduct a survey of the class. Count the number of students who think there has been a significant change in the family's use of the product. You may wish to gather this information by "secret ballot" to encourage truthful responses.

10) Have families been cooperative? What successes and problems have been encountered? Were predictions correct? Why do you think some changes were easier than others?

ALTERNATE ACTIVITY: Have all students "adopted" the same product for each month, and graph results. Which product attitudes were easiest to change? Most difficult?

Evaluation

Name four household chemicals used on a daily basis and describe their harmful effects. Describe alternative to using these chemicals.

Draw a mural to illustrate how hazardous chemicals can enter groundwater.

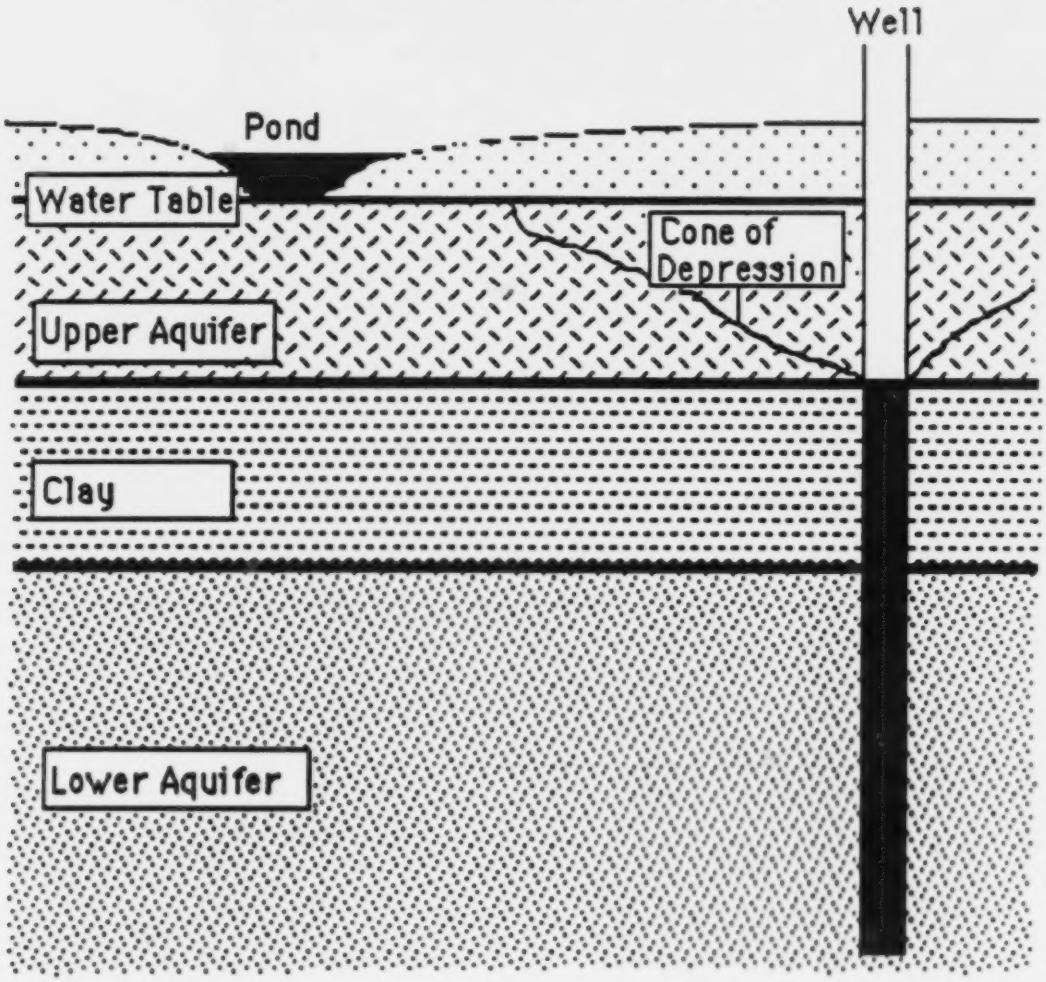
Extensions

1) Graph the results of this segment of the study using a bar graph to represent the positive responses for that month. Have students choose another product, prepare another card, and repeat the activity. After several months (or at the end of the school year examine results. Has the positive response increased?

2) Prepare posters with information on individual products and post them in school halls.

3) Form teams and present information to other classes in school.

BIG CITY BLUES



Objectives

Students will 1) generalize that multiple well use affects the availability of ground- water; and 2) observe the movement of water through an aquifer.

Method

Students construct and demonstrate a ground-water model.

Age: Grades 5-6
Subject: Science, Social Studies
Skills: analysis, application, conceptual development, discussion, experimentation, generalization, inference, media construction (making groundwater model), observation
Duration: Two 45 minute periods
Group Size: any
Setting: indoors
Conceptual Framework: I.A., I.B., I.C., II.B., II.C, II.D., II.F, IV.B
Key Vocabulary: aquifer, cone of depression, hydrologic cycle, precipitation, percolation
Illinois State Goals and Knowledges/Skills for Learning in the Biological and Physical Sciences: Goal 1-G, J; Goal- B,D,G; Goal 3-B; Goal 4-A, D, F, J, K, L, M

Background

Review the hydrologic cycle with students (see "Nature's Water Cycle" activity). Groundwater is water found underground in the unconsolidated materials (sand, gravel etc.) and bedrock (limestone, sandstone etc.). An aquifer is a geologic formation capable of storing and transporting significant volumes of water. Approximately fifty percent of Illinois' population and about 3/4 of the state's community water systems use groundwater. As population if a given area increases, more wells are constructed in relatively close proximity in order to keep up with the demand on water supply. Eventually the rate at which groundwater is being pumped from the wells may exceed the recharge rate through precipitation, resulting in a deficit of available groundwater. This does not mean the water has been permanently removed, only temporarily depleted, forming a cone of depression. A cone of depression is the conical shape of the area surrounding the well that is temporarily depleted when the water is pumped out of an aquifer.

In the Chicago metropolitan area, most surrounding suburbs, after depleting deep bedrock aquifers due to over pumping, have been able to tap into nearby alternate fresh water source, Lake Michigan. This alternative is not always available and many suburbs have declined to tap into Lake Michigan's water due to the expense of building pipelines. Other suburbs have been forced to use Lake Michigan's water due to the high, naturally occurring levels of barium and radium found in the subsurface rock layers.

The natural quality of groundwater is influenced by many other factors including soil, the nature of earth materials, and the amount of water present in an aquifer. Contaminants tend to increase in more populated areas and they also affect groundwater quality. The major purpose of this activity is for students to increase their understanding of how groundwater accumulates and the consequences of its use. Also see "Major Users of Groundwater in Illinois" in the appendix.

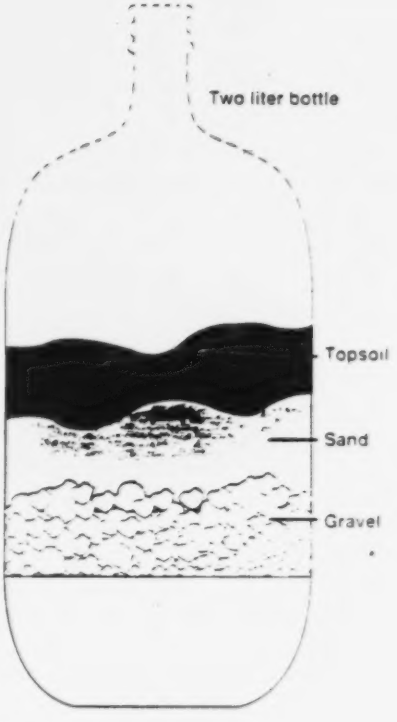
Materials

32 oz. clear or 2 liter clear plastic pop container (cut top off), transparent straws, plastic syringe, washed pea gravel, sand, topsoil, water supply

Procedure

1) Have each student assemble a groundwater model by layering the gravel on the bottom of the container (approximately 2 inches). Position two straws into the container. While holding the straws, layer 3 inches of sand on top of the gravel (NOTE: it may be easier for 2 students to work together to allow one student to hold the straw in place while the other adds sand.) Add 1-2 inches of topsoil on top of the sand.) Straws may need to be removed and cleaned periodically to clear clogging.

2) Add water slowly to saturate the sand and gravel. Discuss how the addition of water represents precipitation. The straws represent wells.



3) Ask students to predict what will happen if the water in the straw is drawn off with a syringe. Will the water level throughout the container drop at the same rate?

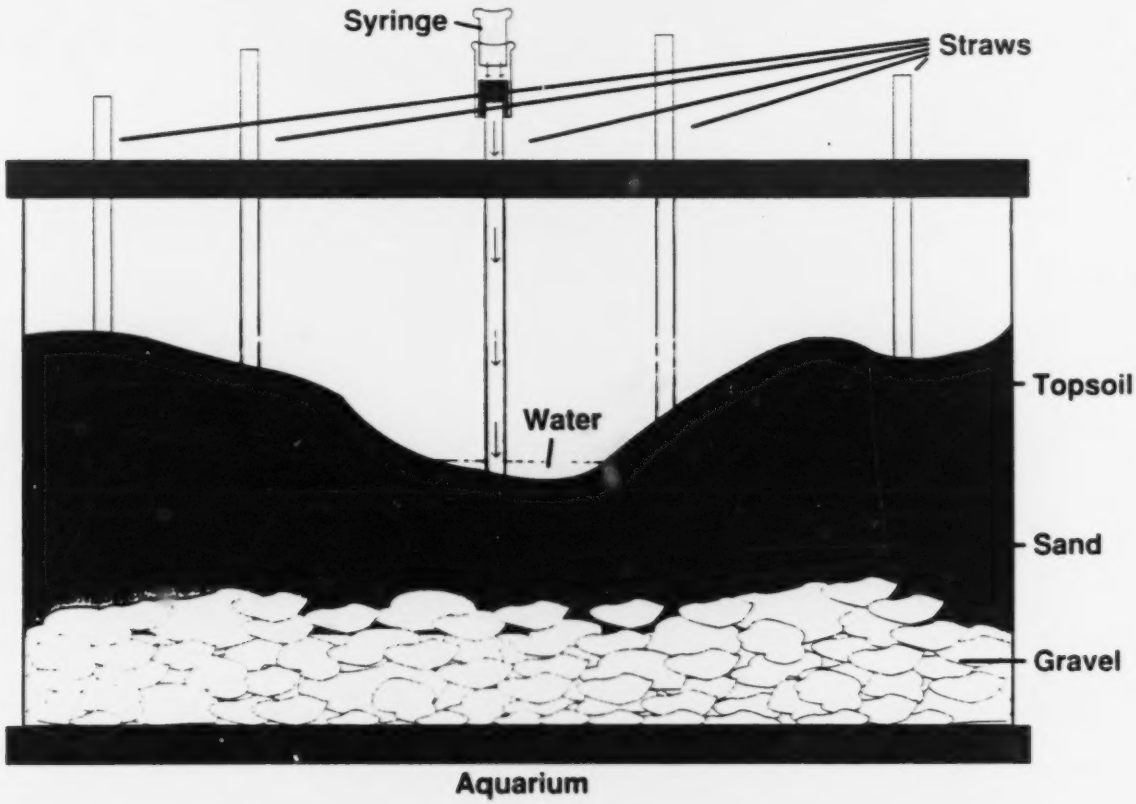
4) Insert a plastic syringe into one of the straws withdrawing the water from within. (NOTE: Syringe should tightly seal the air opening of the straw. A rubberband or a student pinching the opening closed can be used to seal it.) Observe the results of this pumping action of the aquifer. (Students should observe the cone of depression, followed by the water gradually filling in the area.)

5) Insert the second syringe into the second straw and repeat the process. Observe the effect on the level of the groundwater. Discuss cone of depression.

6) Repeat the experiment several times and note any changes on the effect of the groundwater level. Experiment with pumping water simultaneously and one straw after the other. Does this affect the availability of groundwater?

7) What would be the impact on the groundwater if even more "wells" were added? What if they were all pumped at the same time?

ALTERNATIVE ACTIVITY: Use any size aquarium in place of, or as an extension to, individual containers to build one groundwater model for the class. The enlarged model could also include surface water (lake) and students can observe the effects of pumping and recharge on the level of the lake.



Evaluation

Name two factors that influence availability of groundwater. Describe why suburbs in the Chicago metropolitan area have recently changed from pumping groundwater to using water from Lake Michigan.

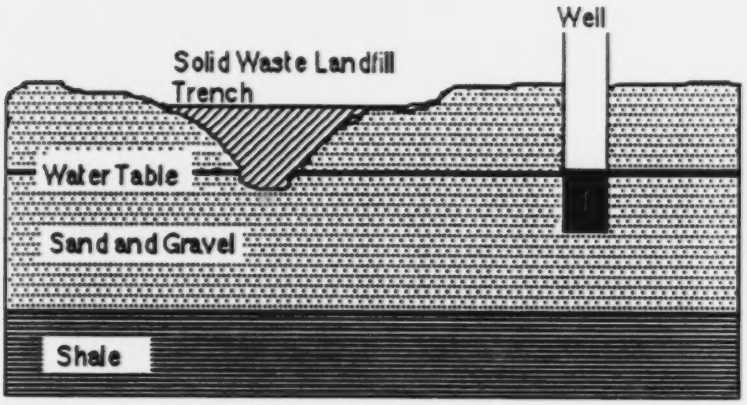
Extensions

1) Add food coloring to syringe water and inject into a well. The colored water represents a contaminant (consider local pollution problems). Observe and discuss the consequences of contaminant entering groundwater. Remind students not to interfere with the process once water has been injected into the system.

2) Investigate how different soils, such as clay, influence contamination ability by replacing gravel with clay, or changing soil proportions. Also see "How Different Soils Affect Water Movement".

3) Discuss the effects of drought on groundwater.

DISPOSAL UNDER MANAGEMENT PLANNING: D.U.M.P.



Objectives

Students will be able to 1) numerically rate hydrogeologic settings for suitability as possible landfill sites; 2) provide and communicate a rationale for site selection for a landfill; and 3) understand the difficulty in designing a landfill site.

Method

Students analyze graphic representations of potential landfill sites according to specified criteria and verbally present justifications for their choice.

Background

Prior to this activity, students should be familiar with concepts of soil permeability (see "Porosity and Permeability" activity), rock strata, and hydrogeology. A sanitary landfill is a method of disposing waste materials. It must comply with the Federal Resource Conservation and Recovery Act (RCRA). (RCRA gives the United States Environmental Protection Agency (USEPA) the power to protect all sources of groundwater from contamination by hazardous waste and provides guidance and support to the states in developing environmentally sound methods of solid waste materials).

A landfill is constructed on the land surface or excavated in earth materials which are, ideally, relatively impermeable, water free, and do not cause or contribute to environmental contamination of groundwater. The most significant hydrogeologic factors influencing

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Age: Grades 9-12
Subject: Science, Social Studies
Skills: analysis, application, discussion, evaluation, problem-solving, reporting, small group unit, synthesis
Duration: Two 45 minute periods
Group size: 4 Groups
Setting: indoors
Key Vocabulary: Earth materials, hydrogeology, leachate, monitoring well, percolation, permeable, rock strata
Conceptual Framework: I.A., II.B., IV.B.1, VI.C
Illinois State Goals and Knowledges/Skills for Learning in the Biological and Physical Sciences: Goal 1-D.I. Goal 2- A, B, F, G, H, Goal 3-D, F, G, K

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site selection include: type of earth materials utilized for trench construction; position of the water table; location of wells; ability to monitor the site and presence; of surface water. Clay and silt provide the best earth materials for landfills because pollutants move slowly in them and many undesirable compounds are absorbed on clay mineral particles. The depth of the water table is also critical and should be well below the bottom of the landfill.

Pumped wells located near landfills are subject to possible contamination. To facilitate monitoring of the site, the earth materials should be uniform in structure and altitude. Proximity of surface water to a landfill site must be considered to avoid its contamination.

Surface water not only has many beneficial uses such as for drinking water, but in heavy rains it can also flood. The subsequent runoff can pick up contaminants in the landfill and carry it further, spreading the contaminants to a much larger area.

Materials

Landfill activity sheet, criteria list

Procedure

1) Discuss current and local techniques in handling waste disposal, and highlight the urgency as well as the dilemmas associated with waste disposal. Focus on the most commonly used technique, the sanitary landfill.

2) State objectives of the exercise and distribute activity and criteria sheet.

3) Discuss the criteria for landfill site selection and have students rank the criteria from 1 (the most significant or important factor to consider) through 11 (the least significant factor). Based on their ranking of the criteria students are to select the most appropriate landfill site from the four diagrams.

4) Divide students into groups of 3 - 4. Each group should rank their priorities, select sites based on their rankings, present findings and support their choice to the group.

5) Discuss the problems students encountered in trying to reach their decision.

Extensions

1) Discuss alternatives to landfills such as recycling, composting and incineration.

2) Role play the situation to represent special interest groups, see "Decision-Making Simulation" activity.

3) Visit a landfill site.

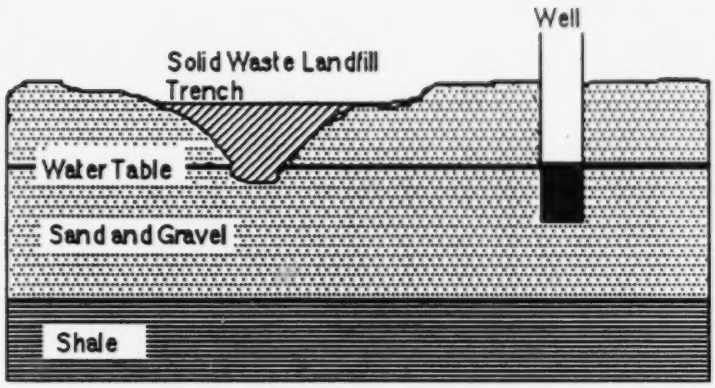
4) Observe a town meeting.

5) Find out how disposal is managed throughout Illinois and what future plans or legislation are planned. See "resources" for contacts.

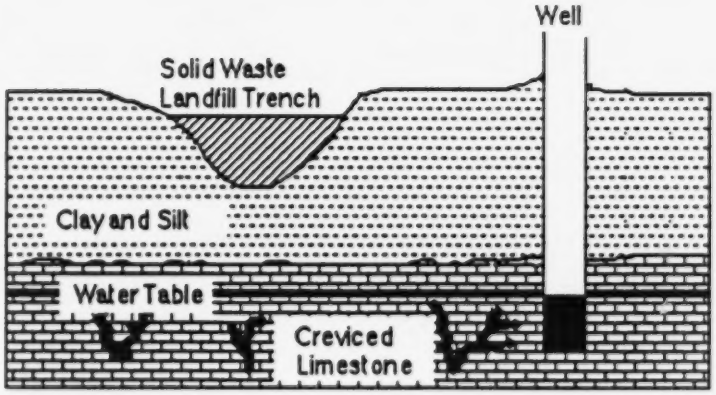
Criteria:

Water Table
Private Wells
Long Term Use
Surface Water
Habitual Change
Amount of Rainfall
Earth Materials
Hauling Distance
Monitorability
Prevailing Wind Direction
Location to Schools
Zoning
Slope
Ownership

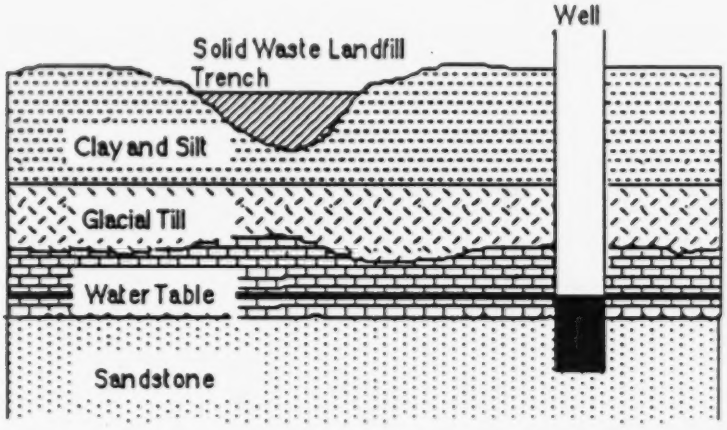
Site 1



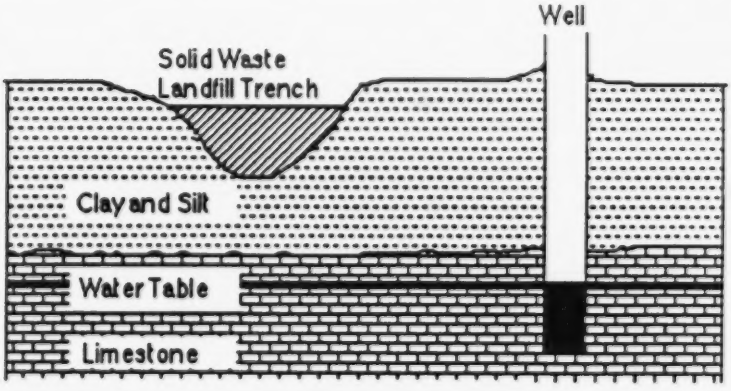
Site 2



Site 3



Site 4



A DECISION-MAKING SIMULATION

Objectives

Students will be able to 1) analyze the processes involved in making decisions; and 2) examine their own values and beliefs related to the environment.

Method

Through role-playing, students read, discuss and analyze the processes involved in making decisions to resolve a hazardous waste landfill problem.

Background

This simulation is designed to involve students in a decision-making process concerning the placement of a hazardous waste landfill. It will help them recognize the complexity of our hazardous waste problem. Although the problem in Jackson Township is not being solved in precisely this manner, it is used as background for this simulation. Students might appreciate the opportunity to attend a local board or council meeting to better understand procedure, etiquette and atmosphere.

Finding locations for hazardous waste disposal is becoming a serious problem as local opposition to hazardous waste landfills increases. No one wants to live near a hazardous waste landfill. If we as an industrial nation are going to produce hazardous wastes, however, we must also dispose of them safely. Discuss this situation with your students.

Reference

National Wildlife Federation. *The Class Project, Conservation Learning Activities for Science and Social Studies*. Washington DC: NWF, 1982, pp. 65 - 69.

Materials

Problem sheet, criteria sheet, copies of role cards, newspaper clippings

Procedure

1. Have students, or groups of students, choose their roles.

2. Give each individual or group its role card, the problem sheet, and the newspaper clipping sheets. These sheets will give your students the background they need. The Board of Supervisors should be given all of the role cards.

3. Discuss the problem sheet with them. Before beginning, answer any questions they may have about their roles. It is also important to discuss the ways they perceive their roles. What are their responsibilities as citizens or board members?

4. Allow the students a day or two to prepare their statements and to conduct any research they feel necessary before presenting their statements.

Age: grades 8 - 12
Subject: Science, Social Studies, Speech, Economics
Skills: analysis, application, discussion, evaluation, problem-solving, small group work, synthesis
Duration: minimum of two 35 minute periods
Group Size: any, small groups of 5 - 10 recommended
Setting: indoors
Conceptual Framework: V.A., V.B., VIII. A. B 1, VII. B.2., VII.B.3.
Key Vocabulary: Environmental Protection Agency, hazardous waste, sanitary landfill
Illinois State Goals and Knowledges/Skills for Learning in the Biological and Physical Sciences: Goal 1-D,P; Goal 2- D,E,G,H; Goal 4-I,

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5. If working in groups, have each group choose a spokesperson to present its point of view to the board.

6. The Board chairman should begin the meeting by explaining the issue and restating the alternatives listed on the problem sheet. Allow each group three minutes to present its statement to the Board. The Board can also decide to offer a different alternative not presented in the problem. If it does, the alternative should be heard first, then the meeting should be recessed to allow the groups time to consider the Board's proposal.

7. After each statement, the Board should be allowed to ask questions of the group. At this point, any group member can answer the Board's questions.

8. Allow about ten minutes for discussion and rebuttal after all statements have been heard.

9. Have the Board recess for five minutes to make its decision. They may choose not to use any of the sites, but they must choose an alternative if one of the three suggested sites is not chosen. When they announce their decision, they must give reasons for their choice and explain why they did not choose one of the other sites.

10. Things to consider and discuss: -Who did they make responsible for present safe disposal?

- Does the method they chose place responsibility with someone outside the county?

- Is it safe to place the responsibility elsewhere for monitoring or disposing of wastes generated in a community?

- What will happen when this landfill is full?

- Who will be responsible for future safe disposal?

- How could Brevard County plan for the future so that a similar problem doesn't occur?

11. Conclude by discussing, either in small groups or as a class: (NOTE: If class is divided into small groups, divide questions so each group concentrates on a few of the questions.)

- What difficulties did the students encounter in preparing defenses for each of the positions?

- What additional information would have been helpful in reaching a decision?

- What part, if any, did the personal interests of the Board of Supervisors play in the Board's decision? Should the personal interests of the Board members play a part in the decision? Why or why not?

- What factors did the Board of Supervisors consider when making its decision? What other factors do class members think the Board should have considered? What factors do students think should be considered in determining the welfare of the county as a whole.

- Identify the people whose needs were considered by the Board as it formulated its plan.

- What effect did the special interest groups and their statements have on the Board? What part should special interests play in the Board's decision-making process?

- Are there county residents whose needs were not represented? Were their interests identified and considered in any way?

- What makes a county resident important?

- Was anyone looking beyond their own special interests and considering the welfare of the county as a whole? Did anyone's point of view change as a result of the hearing?

- What, if any, compromises were made to enable the Board to make its decision? Did they provide some form of compensation to those citizens near the landfill?

Evaluation

Choose a different role to play. Write a paragraph on the positive and negative effects of the landfill from that position. Identify, in your judgement, what seems to be the most responsible decision and explain.

Extensions

1) Have the class do more extensive research on local issues utilizing recent news stories. Use new information and hold a second hearing.

PROBLEM SHEET

In Jackson Township, 165 families must get their water from a truck because their wells have been contaminated by toxic chemicals from a city-owned landfill. The township is solving the water problem by extending the municipal water supply system through pipes to the neighborhood.

However, Jackson Township must still solve the hazardous waste problem by moving the chemicals to another area where they will not leach into the ground. If they are left in the present landfill, they will continue to leach into the groundwater supply and spread the contamination. Brevard County has a related problem. Chemicals from a leaking landfill must be moved to a secure one.

In Brevard County, the Board of Supervisors had decided to build a special clay-lined landfill for the chemicals that must be moved from the present disposal site. The clay lining keeps toxic chemicals from seeping down into the groundwater. Special wells from which water is drawn and monitored for contamination, are built around the landfill. If chemicals are leaching from the landfill, they will show up in the water supply surrounding it. When the landfill is full, it will be capped with clay to seal it.

The money needed to build the landfill and operate it safely will come from county taxes. It will cost $2.3 million to build the landfill. Sending the drums to an operating EPA-approved site 800 miles (1287 kilometers) away would cost $1.4 million. The needed additional funds ($.9 million) for construction of the new landfill would be raised through a bond referendum. If this special landfill is built, Brevard County will be able to accept other chemicals for storage, giving the county an annual income of $100,000 to $200,000. Three possible sites in Brevard County have been proposed for the disposal:

- 30-acre (12 hectare) plot in the Brentwood neighborhood;

- 30-acre plot in the Longworth neighborhood;

- 30-acre plot in the Millerton Shopping Mall;

These sites have been specially selected because the nearest stream to all three sites is at least 500 feet (152 meters) away, and the water table is at least 50 feet (15 meters) below each proposed landfill site. Even though the county will follow EPA regulations in building and monitoring the landfill, the citizens in these areas do not want it near them.

The Board of Supervisors must decide how to solve the problem. Board members are elected, and three of them represent and live in the neighborhoods which are being considered as sites. A hearing, which promises to be lively, is being held to discuss the problem. The citizens of the three proposed landfill sites have asked for time at the hearing to state their objections.

Role Cards - A Decision-Making Simulation

BOARD OF SUPERVISORS

The decision rests with you! Where should the chemical landfill be located? It is up to you to recognize your own special interests and the interests of each group making statements before the Board. The decision you make must go beyond the special interests of any one group and consider the best interests of the county as a whole. Your first task is to select the three board members who live in and represent each of the three areas where the landfill could be located. Then you should consider these questions:

1. What are the advantages and disadvantages of each location for the landfill? What, if any, other options can you consider?

2. How do you take into consideration the feelings of the local citizens in making your decision?

3. What criteria are you going to use to analyze the statements made by the citizens? Make a list of them.

4. What factors besides the local citizen reaction will you be considering as you work toward a decision?

5. What parts will all of the factors play as you reach a decision?

6. Is there room for compromise in reaching a decision? If so, do you think citizens will be willing to make compromises? In what ways? What compromises can you offer them? You can ask questions of each group after it has presented its point of view. As a group, consider all the alternatives open to you for disposal of the chemicals. If you like, you can consider other solutions as well, and present them to the citizens at the beginning of your board meeting. If you decide to do this, recess the Board and allow each group to consider your proposal and develop lists of questions and concerns to be answered before you make the final decision.

THE ECO-CHEM CONTROL CORPORATION

You manage an EPA-licensed landfill corporation for toxic waste disposal. You own a licensed chemical landfill located 800 miles (1287 kilometers) from Brevard County. The clean-up would be very expensive - $1.4 million for the county to send the chemicals from their dump to your landfill, but they would not have to build their own. You must convince the Board that it is better to send the chemicals to your landfill. In your statement, answer these questions:

1. Why is your landfill safe?

2. How do you manage your landfill?

3. What advantages would there be for the county if it send its chemicals to you?

THE ANDERS LANDFILL AND DUMP COMPANY

You will get the contract to develop the landfill if it is built in Brevard County. You need the $2.3 million contract. Your business has been in a slump lately. You must convince the Board of Supervisors to build the landfill in Brevard County. How will you do it? Discuss your strategy and prepare a statement for the Board. As you write your statement, consider these questions:

1. Why is it safe to build this landfill?

2. What are the advantages of having the landfill located in the county?

3. Why should you be given the contract?

County Planner

You think the landfill shuld be located in the county because the county will receive between $100,000 and $200,000 annually from companies bringing their chemical wastes to the landfill. This money can be used to increase services to the county. Parks and a new swimming pool can be built, and county roads can be improved. You must prepare a statement for the Board of Supervisors which will persuade them to locate the landfill in the county. Your statement should point out the benefits the county will be able to finance with the profits from the landfill.

You do not know where within the county the landfill should be built. However, you do not want it built in the area where you live.

The Citizens of the Brentwood Neighborhood

You do not want the landfill in your area! You are afraid the chemicals will evaporate into the air or seep into the groundwater aquifer. Your water supply comes from the wells which you are afraid will be contaminated. There are many young children in your neighborhood and they play only 100 yards (91 meters) from the potential site for the chemical landfill. Your neighborhood begins 300 yards (274 meters) from the site.

You must prepare a statement for the Board of Supervisors to persuade them to locate the landfill elsewhere. The attached news clippings about other situations may help you. Try to answer these questions in your statement:

1. What health hazards does the landfill pose to you and your families?
2. Your taxes are being used to pay for the landfill. Is the landfill the best use of your taxes?
3. Where should the landfill be constructed?
4. Are there better disposal methods? What are they?
5. Is there something the county supervisors could do which would minimize your objections to having the landfill close to your area? If you are willing to make compromises in your position, propose it to the Board during the hearing.

The Citizens of the Longworth Neighborhood

You do not want the landfill in your area! You are afraid the chemicals will get into the air and water and cause health problems. Your neighborhood is only 300 yards (274 meters) from the proposed landfill site.

Your taxes are being used to build the landfill. As taxpayers, you think you should have the right to stop the landfill. You must prepare a statement for the Board of Supervisors to persuade them to locate the landfill somewhere else. The attached articles about other situations may help you. Try to answer these questions in your statement:

1. What health hazards does the landfill pose to you and your families?
2. Your taxes are being used to pay for the landfill . Is the landfill the best use of your taxes?
3. Where should the landfill be constructed?
4. Are their better disposal methods? What are they?
5. Is there something the county supervisors could do which would minimize your objections to having the landfill close to your area? If you are willing to make compromises in your position, propose it to the Board during the hearing.

The Business People of the Millerton Mall

You do not want the landfill in your area! You are afraid it will contaminate the water supply for the mall and hurt your business. People might not shop at a mall near a chemical landfill, and you might have trouble keeping employees if they are a afraid to work near a hazardous waste landfill. You are also afraid that the chemicals could cause health problems for you since you spend six days a week at the mall. The landfill would be located at a site 300 yards (274 meters) from the mall.

You must prepare a statement for the Board of Supervisors to persuade them to located the landfill somewhere else. The news clippings about other situations may help you. Try to answer these questions in your statement:

1. What health hazards does the landfill pose to you and your customers?
2. Your taxes are being used to pay for the landfill. Is the landfill the best use of your taxes?
3. Where should the landfill be constructed?
4. Are there better disposal methods? What are they?
5. Is there something the county supervisors could do which would minimize your objections to having the landfill close to your area? If you are willing to make compromises in your position, propose it to the Board during the hearing.

A DECISION-MAKING SIMULATION - NEWS CLIPPINGS

A NASA STUDIES A-WASTE DISPOSAL IN OUTER SPACE (May, 1980)

NASA has awarded a $296,000 contract aimed at learning if potentially dangerous nuclear wastes can be fired into orbit around the sun, into another solar system, or elsewhere in the universe. The company receiving the contract is to evaluate how best to launch nuclear trash, where in space to put it, how to protect the payload during launch and in space, and how to bring the payload back if there is an aborted liftoff. The program is a joint effort by the National Aeronautics and Space Administration and the Department of Energy.

PROCESSED WASTE "SAFE ENOUGH TO EAT" (June, 1980)

In Hooksett, New Hampshire, the proposed $10 million hazardous waste processing plant will convert acids, alkalis, and heavy metal sludge into a rock-like substance that can be used as a base for highway construction or as an erosion control material. "It will yield by-products safe enough to eat," says the president of the firm that wants to build the processing plant.

JUSTICE DEPARTMENT SUES WASTE PRODUCERS (July, 1980)

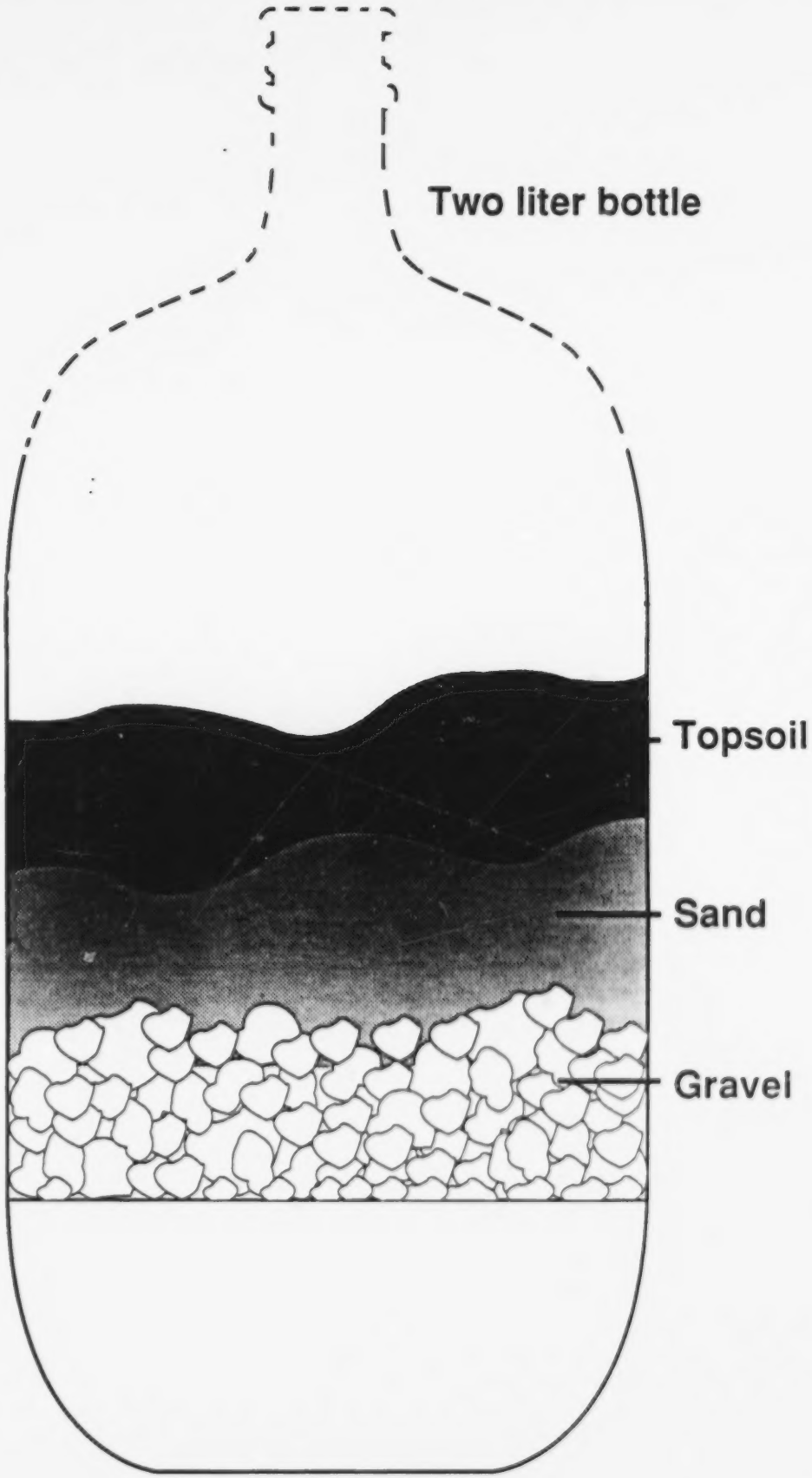
The Justice Department has asked the U.S. District Court in Baton Rouge, Louisiana to keep twelve oil and chemical companies from disposing any wastes, hazardous or otherwise, at two sites near Baton Rouge where carcinogens and poisons are leaking into the environment. One of the sites is a large vertical hole drilled into a bluff. It was closed several years ago after it had been filled with waste, and covered with plastic and a layer of earth. Since then, the plastic has disintegrated and the earth has washed away. The Justice Department has asked the court to order the defendants to repair the plastic sheeting and install fences around the areas after doing tests and sampling.

COMPANIES DETOXIFY WASTES CHEMICALLY (September, 1980)

Companies worried about leaking chemical drums or landfills like the Love Canal are trying to remove poisons from their wastes by chemically converting compounds into their harmless components. A researcher working to develop detoxification methods says, "If you have to store toxic wastes, you're just postponing a solution". An officer in another research company says, "Almost total reliance has been placed on landfills. But burial is just long-term storage." While some wastes can't be completely detoxified, their hazardous wastes can be limited. These processes are expected to increase in popularity because trucking of chemicals to special dumps is becoming more and more expensive.

TITAN SILOS FOR SOLID WASTE? (July, 1980)

The southern Idaho desert is the final resting place for thousands of tons of toxic chemicals. The 80-acre facility, which formerly housed Titan I nuclear missiles, offers the extreme in safe disposal: "encapsulation" in underground silos designed to withstand forces as severe as earthquakes and bombing attacks. The Air Force abandoned the sites in 1965 when the Titan became obsolete, and a disposal company later bought it. The president of the company says, "We are 3,300 feet above the water table, and there is nothing but impermeable clay between the site and the watertable. It is locked up forever and cannot get out." A senior specialist with the Idaho Department of Health and Welfare says that the company has a pretty clean operation that meets all state standards. The company expects to buy other similar sites for disposal of more waste materials.



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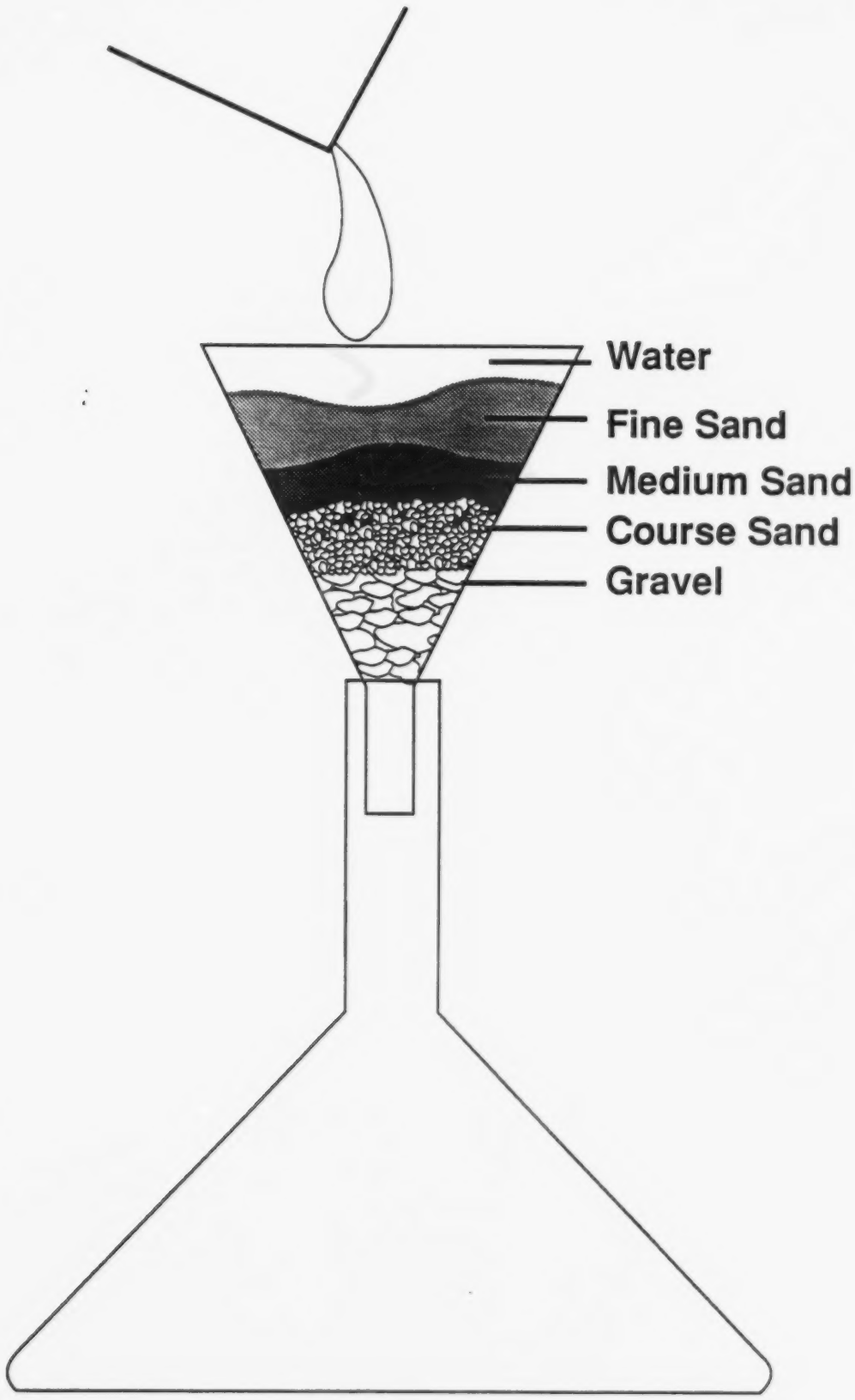
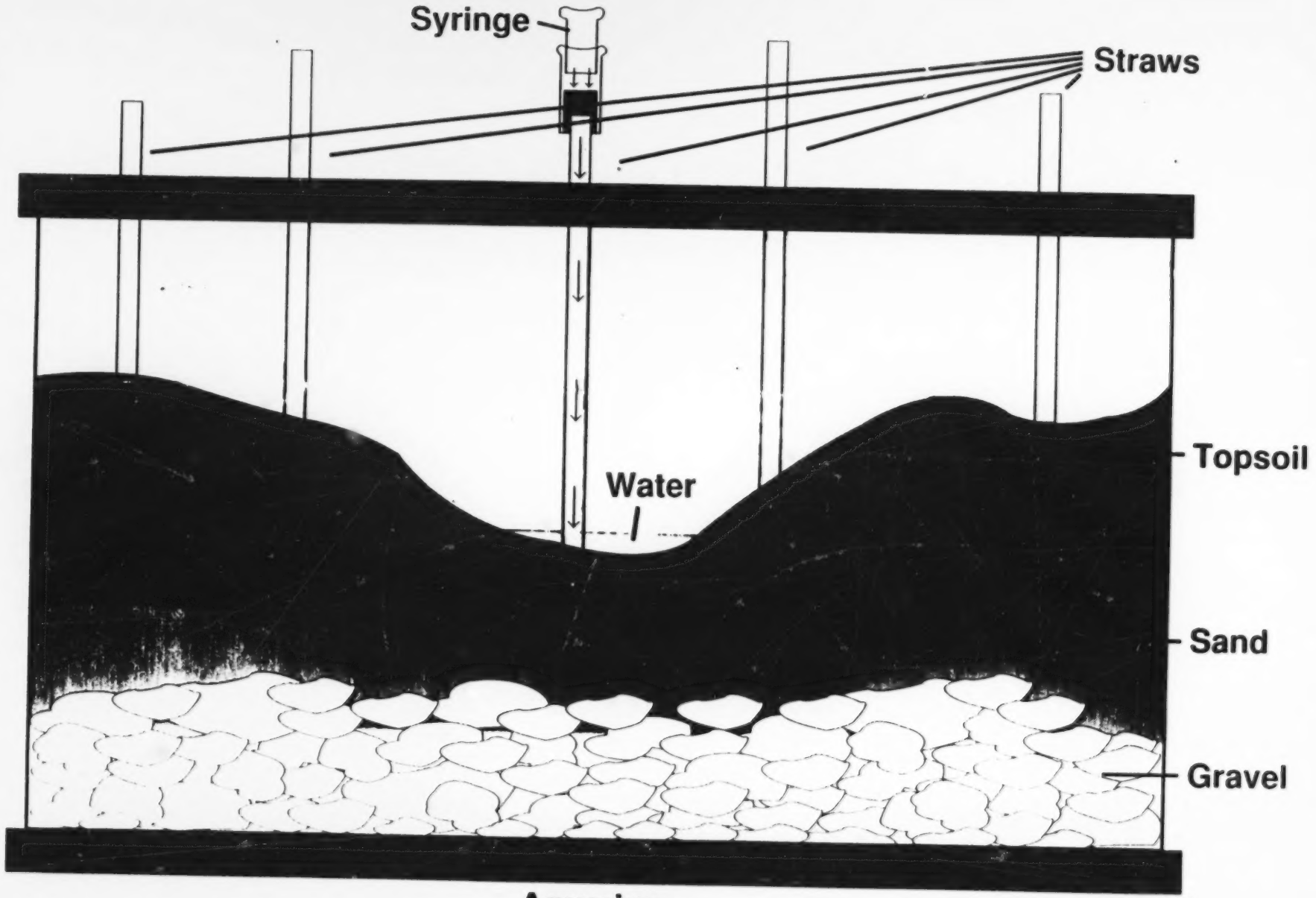

Water
Fine Sand
Medium Sand
Course Sand
Gravel



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37 44

From Sink to Stream:

Following the Wastewater Treatment Process

1 Indoor pipes carry wastewater from the drains to underground sanitary sewer pipes. The water then goes to a sewage treatment plant.

2 Runoff from roofs, ground and streets goes into a street drain that leads to a storm sewer which empties into nearby waterways.

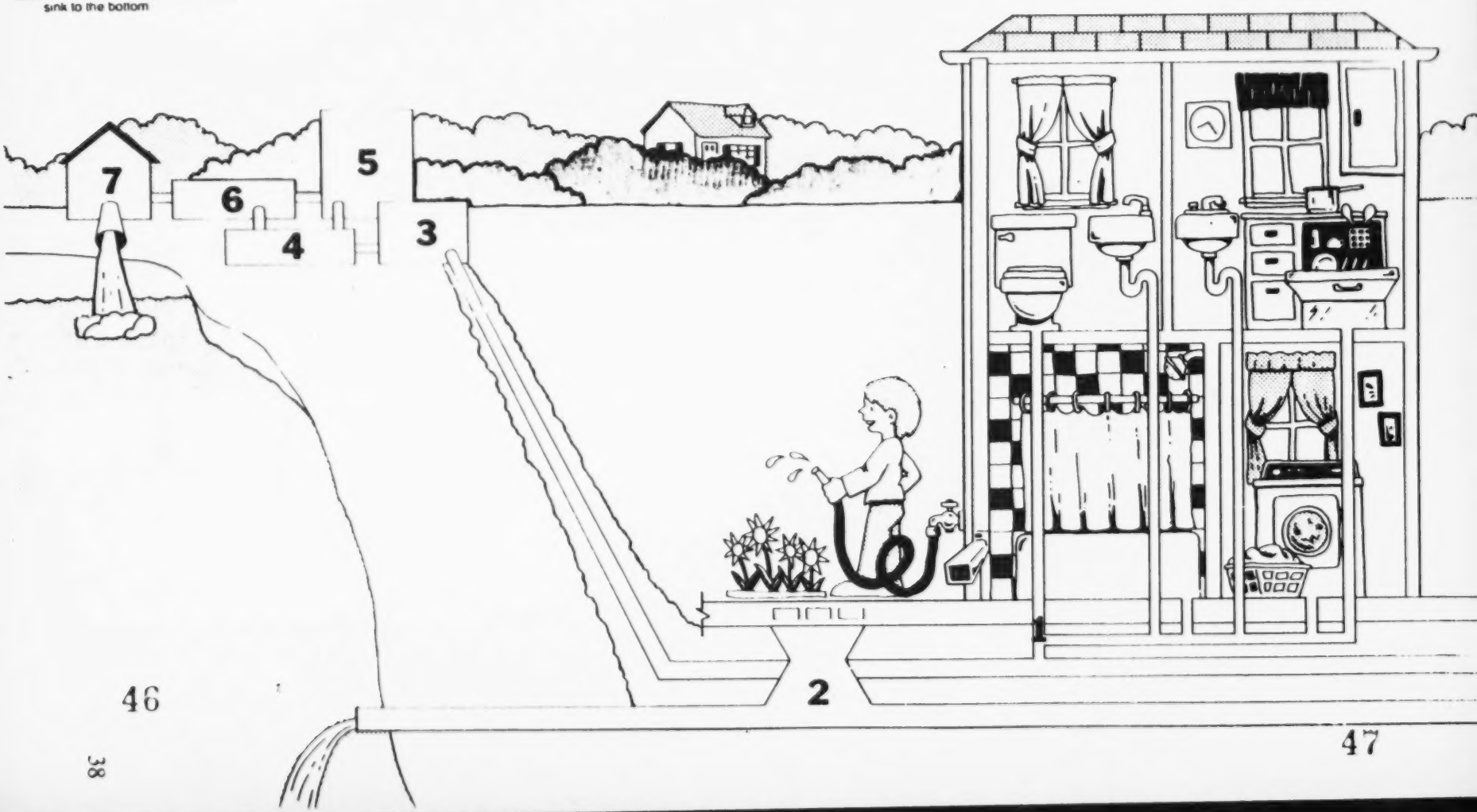
3 Wastewater travels into the screening house where all the large waste particles are trapped.

4 The water then goes to a sedimentation tank where grit and gravel sink to the bottom.

5 In secondary treatment, the water is pumped into an aeration tank where it is mixed with air for several hours.

6 The water goes to a second sedimentation tank to settle the sludge. Sludge is particles of solid waste left after treatment.

7 Chlorine gas is then pumped into the water. The chlorine kills germs that cause disease. Treated water is then released to the waterway.



INTERESTING FACTS ABOUT ILLINOIS GROUNDWATER

* Illinois is a water-rich state with 34-46" of annual rainfall.

* Water practically surrounds Illinois and underlies most Illinois land.

* About half of Illinois' population uses groundwater.

* About 3/4 of Illinois' community water systems use groundwater.

* Over 410,000 wells are used to tap Illinois groundwater.

* Almost all Illinois groundwater is recharged locally.

* Only about 1/7 of the potential groundwater supply is presently being used.

* Water wells range in depth from 20 feet to over 2800 feet.

* A modern large-scale community well, pump and connection may cost up to a million dollars.

* Less than 8% of tested Illinois community wells show quantifiable levels of contamination.

ILLINOIS GROUNDWATER: MYTHS AND FACTS

Myth 1: Underground rivers bring water from great distances, such as from Lake Superior and Pennsylvania.

Fact: Almost all Illinois groundwater is recharged locally.

Myth 2: If a water well becomes contaminated, a new well nearby will produce good water.

Fact: Unless the new well extends to a new, deeper aquifer and there are no connections between the aquifers, the new well will likely be contaminated, too.

Myth 3: The soil filters all contaminants from percolating water.

Fact: The soil filters out many contaminants, but highly soluble materials may pass through it. Under certain conditions, the soil may add contaminants.

Myth 4: Groundwater is naturally free of contaminants.

Fact: In certain areas, groundwater naturally contains materials which make it unfit for consumption.

Myth 5: Wetlands, lakes and rivers are principal sources of groundwater recharge.

Fact: These water bodies are more typically discharge areas for groundwater. Most groundwater is recharged by precipitation soaking into the land and slowly percolating down to the water table.

Myth 6: Recoverable groundwater underlies all Illinois land.

Fact: A majority of Illinois land is underlain with recoverable groundwater. However, many wells produce only enough water for households or small farms, and the highly mineralized water from some wells is unsuitable for use without expensive treatment. Examples of inadequate groundwater supplies can be seen in certain areas of southern Illinois, where many community water systems use surface waters.

Myth 7: Farmland tiling prevents groundwater recharge.

Fact: Farm tiling or subsurface drainage lowers seasonal high water tables only to the level of the tile. Tiling has a negligible effect on groundwater recharge.

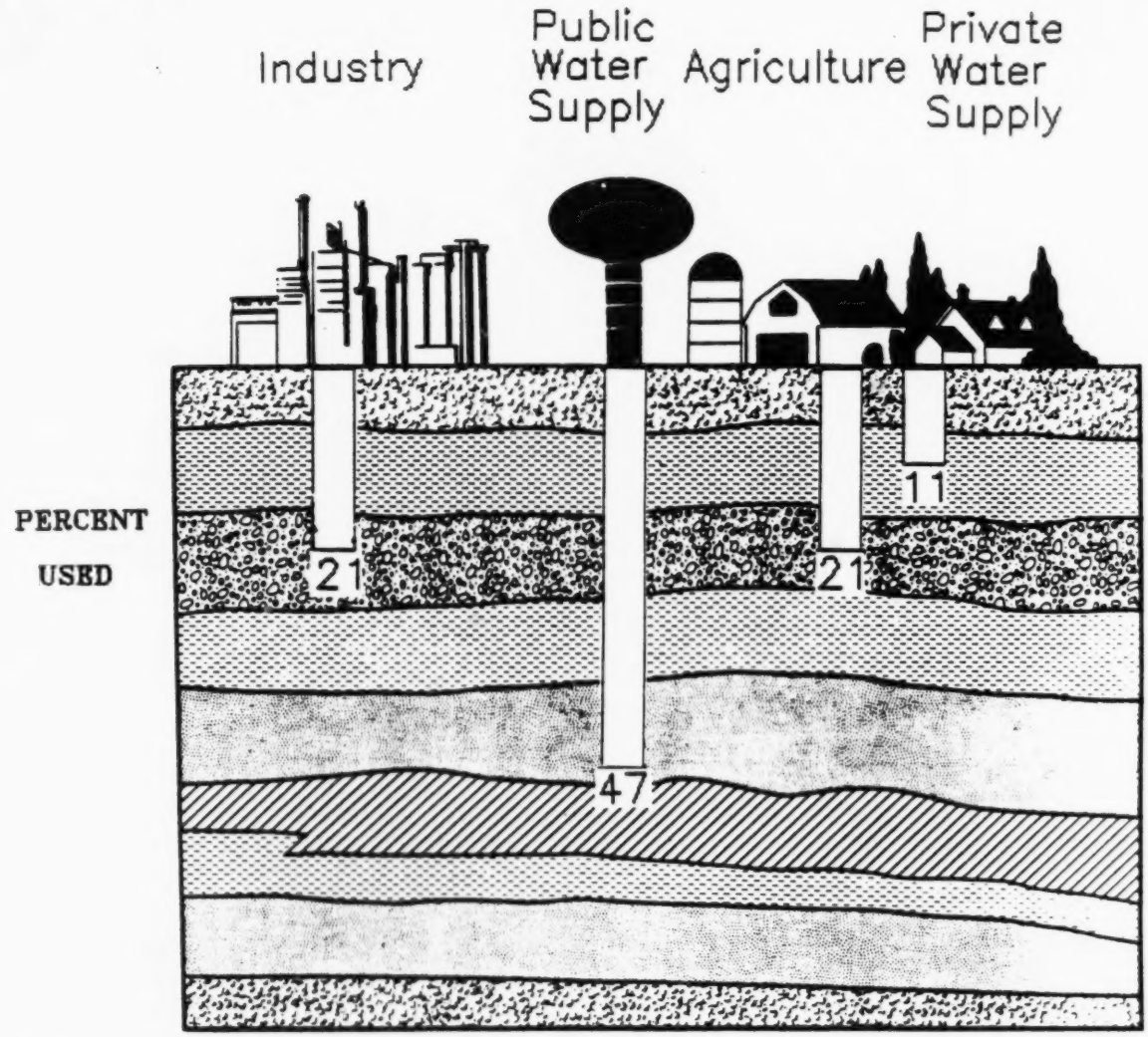
Myth 8: Groundwater does not move through rock layers.

Fact: Groundwater may move readily through fractured or highly porous bedrock formations, but less readily in other dense bedrock formations.

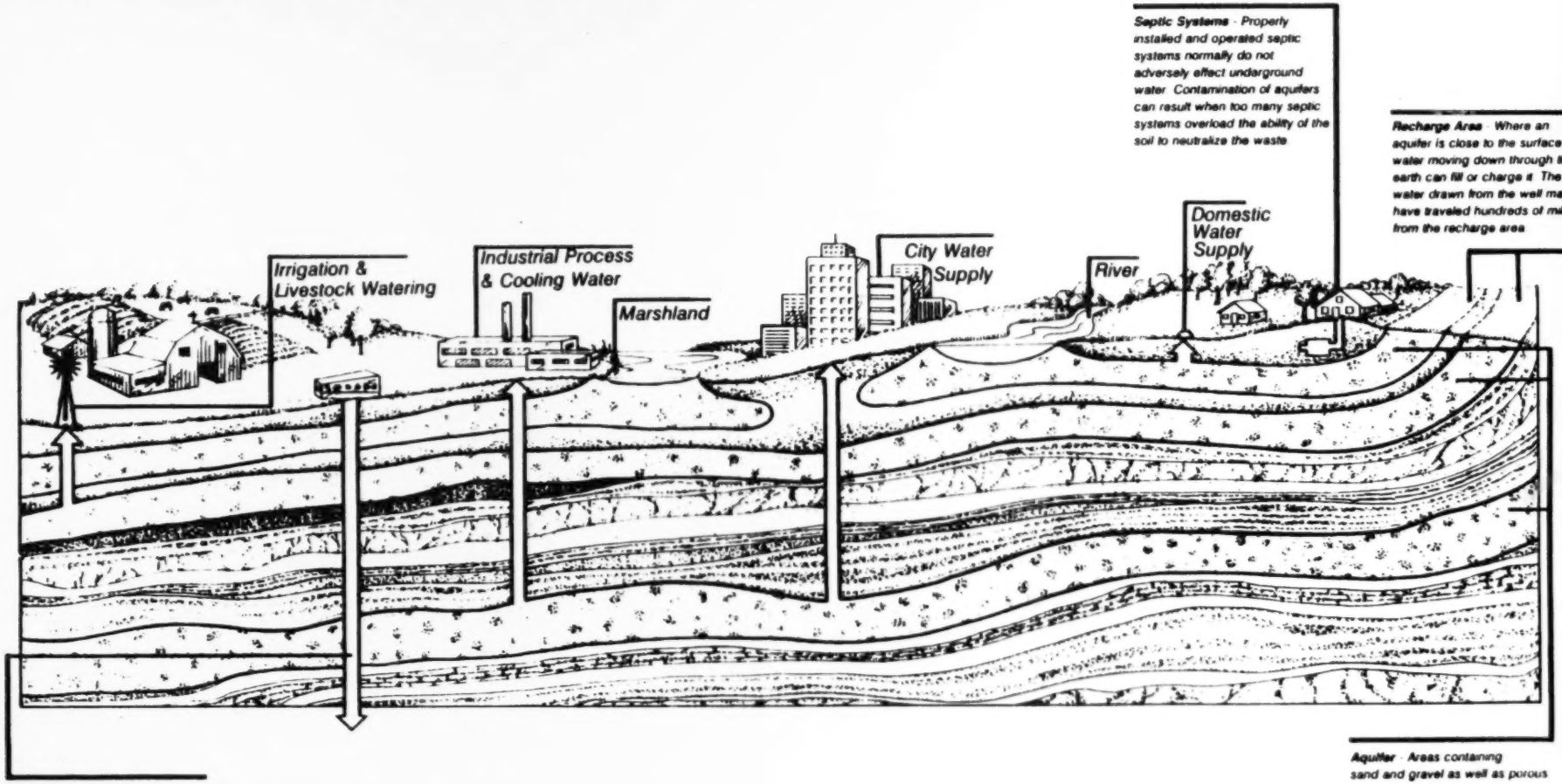
Myth 9: Soils are uniformly permeable to groundwater.

Fact: The water permeability of Illinois soils ranges from less than 0.06 inches/hour in certain clay soils to greater than 20 inches/hour in some sandy soils.

MAJOR USERS OF GROUNDWATER IN ILLINOIS



The Human Impact on Groundwater



Septic Systems - *Properly installed and operated septic systems normally do not adversely effect underground water. Contamination of aquifers can result when too many septic systems overload the ability of the soil to neutralize the waste.*

Recharge Area - *Where an aquifer is close to the surface, water moving down through the earth can fill or charge it. The water drawn from the well may have traveled hundreds of miles from the recharge area.*

Underground Injection - *Some liquid waste can be injected into deep underground geologic formations. In Illinois there are eight wells that inject brine, acid and inorganic salts to depths 2500 to 5500 feet below the surface.*

Aquifer - *Areas containing sand and gravel as well as porous or fractural bedrock such as sandstone and limestone are typical aquifers. Local shallow aquifers may be measured in acres while deep regional aquifers may extend through several states and exceed 100,000 square miles.*

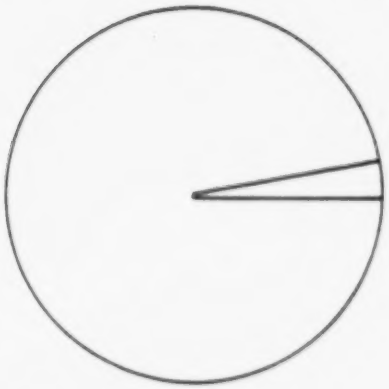
U.S. RESIDENTIAL WATER USE

Drinking and Cooking	5
Bathing	30
Toilet flushing	40
Laundry	15
Dishwashing	5
Miscellaneous	5
	100%

(Source: J. M. Last, 1980)

WORLD WATER

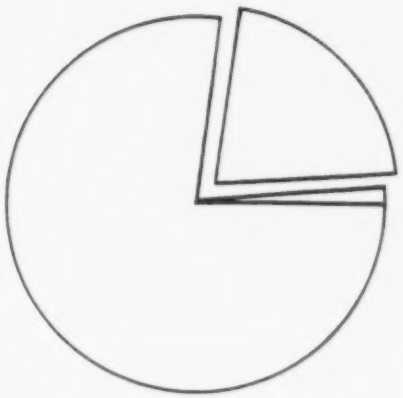
Salt Water
97%



Freshwater
3%

WORLD FRESHWATER

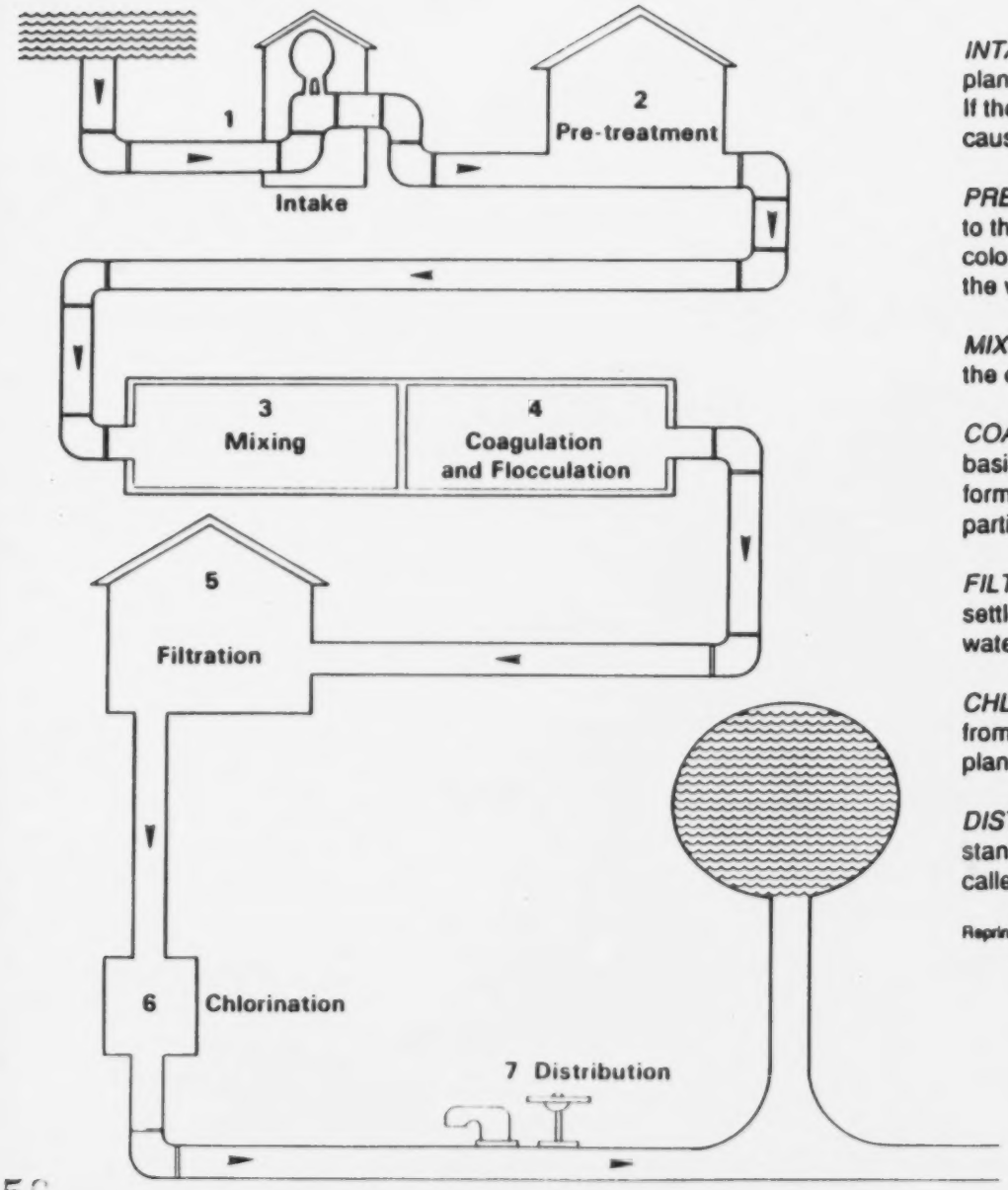
Icecaps
77%



Groundwater
22%

1% Lakes
Rivers &
Atmosphere

Source: U.S. Dept. of Interior



INTAKE: Water from a surface source, or a river is drawn into a treatment plant. Intake screens strain out large debris such as fish, sticks and plants. If the source is groundwater, the screening process is done by nature because the water is clean from traveling through layers of sand and rock.

PRE-TREATMENT: Chemicals such as chlorine, alum and lime are added to the water to remove impurities, soften the water and destroy bad tastes, colors and odors. Excess lime can also be added to remove minerals from the water which leave deposits called scale.

MIXING: The water is then stirred by mechanical mixers. The mixers stir the chemicals through the water.

COAGULATION & FLOCCULATION: The water then travels to a large basin. The chemicals cling to the impurities in the water **(coagulation)**, forming large, heavy particles. These particles are called **floc**. These large particles become heavy and settle to the bottom of the sedimentation tank.

FILTRATION: From the sedimentation basin where most of the floc has settled to the bottom, the water travels through sand beds which filters the water to remove any remaining impurities.

CHLORINATION: Chlorine is added to kill bacteria and keep the bacteria from growing as the water travels to the consumer. Most water treatment plants also add flouride at this point.

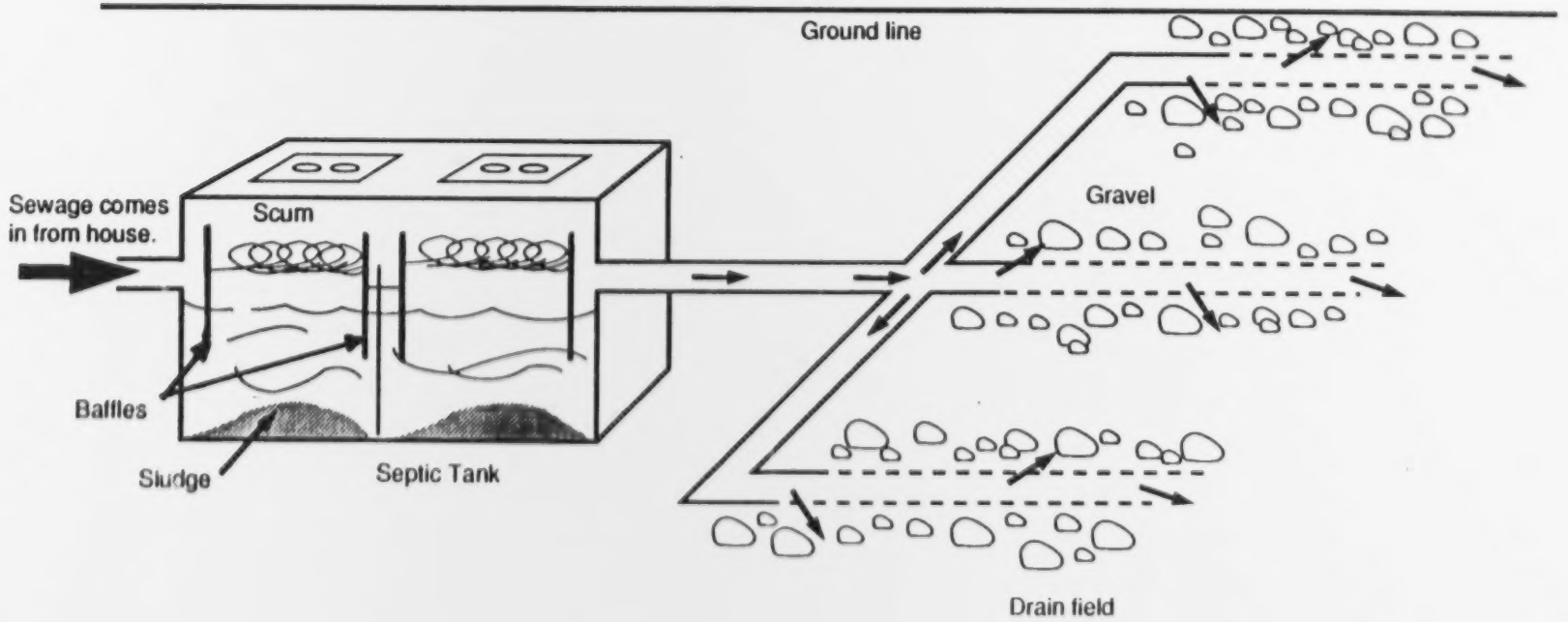
DISTRIBUTION: After the water is clean, it is stored in an elevated tank, stand pipe, or covered reservoir. The water then travels through large pipes called mains to houses, schools and businesses.

Reprinted from *The Story of Drinking Water*, by permission. Copyright ©1984, American Water Works Association

The Drinking Water Treatment Process

SEPTIC TANKS AND DRAIN FIELDS

A Septic tank is a large underground concrete container that looks like this.



GLOSSARY

ABSORB - To soak in or, take in, like a sponge.

AQUIFER - A unique group of earth materials capable of storing and transmitting significant volumes of water to a well or spring. Derived from Latin word meaning "water carrier".

BEDROCK - Solid rock beneath the soil and unconsolidated rock layer.

BIODEGRADABLE - A substance that can be broken down by microorganisms into simple, stable compounds such as carbon dioxide and water.

CLAY - Unconsolidated earth material with a particle size less than 0.01 millimeter (mud).

CHEMICAL HAZARD - Any chemical substance that is toxic or hazardous to life.

CHEMICAL WASTE - Any chemical product that is no longer useful, example: lime sludge.

CONSERVATION - The use of natural resources in a way that assures their continuing availability to future generations; the wise and intelligent use or protection of natural resources.

COMPACTED SOIL - Soil which is pressed together, or firmly packed.

CONDENSATION - The process by which a substance changes from the vapor state to the liquid state.

CONTAMINANT - Any substance that has made water or soil unfit for use.

CONSERVATION - The care, protection and wise use of natural resources.

CONE OF DEPRESSION - The conical surface of the water level created in an aquifer due to pumpage.

DISPOSAL - To get rid of waste.

EVAPORATION - The process by which water becomes vapor in the atmosphere.

FLOCCULATION - The clumping of fine particles in the waste treatment process, such as the clumping of clay particles which can be brought about by the addition of lime.

GROUNDWATER - Also ground water. Water in the zone of saturation that comes from beneath the surface of the ground, underground water. Derived largely from precipitation and percolating surface water. Water that comes from wells or springs.

GRAVEL - Unconsolidated earth material between 0.1 and 10 millimeters.

HAZARDOUS WASTE - Waste, or combination of wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may cause or significantly contribute to an increase in mortality or an increase in serious irreversible or incapacitating illness.

HYDROLOGIC CYCLE - The water cycle. The movement of water from the atmosphere to the earth, and again to the atmosphere through condensation, precipitation, evaporation and transpiration.

HYDROLOGY - Pertaining to the occurrence, circulation, distribution, and properties of water on the earth and the earth's surface.

INFILTRATION - Downward flow or seepage of water through the pores or spaces in rock or soil.

IRRIGATION - To supply land with water by means of artificial ditches, subsurface pipes, or sprinklers.

LANDFILL - A facility where refuse is covered with a conforming layer of earth without creating a nuisance or hazard to public health.

LIMESTONE - Sedimentary rock composed of calcium and magnesium ($CaCO_3$, $MgCO_3$) that has a high ability to neutralize acid.

MONITORING WELL - A well constructed into an aquifer, where samples of water are taken and tested routinely for contaminants.

MUNICIPALITY - Any city, village or incorporated town.

NITROGEN-FIXATION - the conversion of elemental nitrogen from the atmosphere to organic combinations or to forms readily utilized in biological processes. Normally carried out by bacteria, living symbiotically in legumes or by free-living soil bacteria.

ORGANIC MATTER - Of, having the characteristics of, or derived from living plants and animals.

PERCOLATION - Downward flow or seepage of water through the pores or spaces of rock or soil.

PERMEABILITY - The ability of substance such as soil to transmit water or other liquids.

PREDICTION - To declare in advance on the basis of observation.

PRECIPITATION - Hail, mist, rain, sleet or snow deposited on land from the atmosphere.

POROSITY - The percentage of the total volume of a material that is open space.

PURIFICATION - Process to rid of impurities.

RECHARGE AREA - An area where water flows into the earth to resupply an aquifer.

RECYCLE - To use again and again.

ROCK - Any naturally formed, consolidated or unconsolidated material (but not soil) consisting of two or more minerals.

RUNOFF - Water that drains or flows off the surface of the land.

SAND - Unconsolidated earth material with particle size between 0.1 to 10 millimeters.

SEPTIC TANK - Concrete or steel chamber buried underground for disposal of sewage.

SEWAGE (WASTEWATER) TREATMENT PLANT - A processing and treatment location for sewage generated from a municipality or an industry before it is released into lakes, oceans, rivers or streams.

SILT - Unconsolidated earth material with particle size between 0.01 and 0.1 millimeters.

SOIL - The weathered layer of material at the land surface that supports plant growth.

STRATA - A horizontal layer or section of material.

STRATIGRAPHIC - The arrangement of rocks in layers or strata.

SURFACE WATER - All water on the surface of the earth, as distinguished from groundwater. Lakes, ponds, streams, rivers, oceans, and puddles.

TILL - Unconsolidated mixture of clay, silt, sand, and gravel resulting from glaciation.

TOPSOIL - The upper layer of soil, surface soil.

TRANSPIRATION - The process in which water vapor is released into the atmosphere through plants.

TOXIC - Relating to or caused by a poison.

UNCONSOLIDATED EARTH MATERIALS - Loose rock materials below the soil and above the bedrock, glacial till.

WATER CYCLE - the continuous circulation of water in systems throughout the planet, involving condensation, precipitation, runoff, evaporation and transpiration.

WATER QUALITY - Standard of acceptability the government has set for clean water.

WATER TABLE - The upper surface of the saturated zone.

WATER VAPOR - The gaseous state of water.

WATER TREATMENT PLANT - Location for treatment of drinking water through the process of (1) intake, (2) pretreatment, (3) mixing, (4) coagulation and flocculation, (5) filtration, (6) chlorination, (7) distribution.

WATER WELL - Any excavation that is drilled, cored, bored, dug or otherwise constructed when the intended use is for the location, diversion, artificial recharge, or acquisition of groundwater.

WETLAND - Any land area that tends to be regularly wet or flooded such as bogs, swamps, marshes or estuaries.

ZONE OF AERATION - Area between ground surface and water table where most of the spaces in the soil and rock are filled with air rather than water.

ZONE OF SATURATION - Area underground in which every available space is filled with water.

GROUNDWATER RESOURCES

ILLINOIS STATE AGENCIES

A variety of brochures, booklets, posters, educational kits and audio-visuals are produced by state agencies and are available upon request for free or at low cost.

Illinois Department of Conservation (DOC), Division of Forest Resources and Natural Heritage, Lincoln Tower Plaza, 524 South Second Street, Springfield, IL 62706. (217) 782-2361.

Illinois State Board of Education (ISBE), 100 North First Street, Springfield, IL 62794-9276. (217) 782-3397.

Illinois Environmental Protection Agency (IEPA), Office of Public Information, 2200 Churchill Road, P.O. Box 19276, Springfield, IL 62794-9276. (217) 782-5562.

A Primer Regarding Certain Provisions of the Illinois Groundwater Protection Act. Outlines legislation of 1987 (Public Act 85-0863). Describes principal aquifers and chemical contamination.

All About Groundwater. Excellent background information on groundwater suitable for elementary students, includes diagram of hydrologic cycle as well as terms and definitions. 4 pages.

Groundwater and You: Keeping Your Water Supply Safe. (pamphlet) Contains farm pollution checklist for chemicals, herbicides and fertilizers.

Underground Water in Illinois. Excellent background information on groundwater suitable for junior and senior students. Includes distribution of world's water supply chart, sources of contamination, and groundwater management techniques. 12 pages.

Illinois Department of Energy and Natural Resources (ENR), Groundwater, 325 W. Adams, Springfield, IL 62704-1892. (217) 785-2800.

The Illinois Groundwater Protection Act: A Safeguard for Illinois Water Supply. Summarizes IGPA provisions.

Groundwater Protection Education Materials List. Lists brochures and audiovisual materials available relating to groundwater.

Hazardous Waste Research and Information Center (HWRIC), 1808 Woodfield, Savoy, IL 61874. (217) 333-8941. (see Teaching Aids)

Illinois Natural History Survey, 172 Natural Resources Building, 607 East Peabody Drive, Champaign, IL 61820. (217) 333-6880.

The Natural Resources of Illinois. Maps of groundwater, $10.

Illinois State Geological Survey (ISGS), ISGS Publications, Natural Resources Building, 615 E. Peabody Dr., Champaign, IL 61820. (217) 333-4747.

A variety of ISGS publications are available free or at low cost to teachers who are interested in groundwater studies including:

> Reports on Groundwater Geology are available for each region in Illinois. The reports summarize groundwater principles, factors that control groundwater availability, and methods of developing groundwater supplies. Reports include distribution maps.

Illinois State Water Survey (ISWS), 2204 Griffith Drive, Champaign, IL 61820. (217)333-8888. Reports and publications available covering groundwater quality, well construction and quantitative data on aquifer performance. Education materials include:

> Groundwater Contamination in Illinois. Covers ground- water definitions, natural and man-caused groundwater quality problems, and protection measures.

Speakers Bureau, Contact: ENR. Government, research, business, association and industry speakers are available for various groundwater presentations.

BACKGROUND INFORMATION

Groundwater Issues and Answers, American Institute of Professional Geologists, 7828 Vance Drive, Suite 103, Arvada, CO 80003. (303) 431-0831. Publication on groundwater as a resource that needs proper management.

Toxicants in Consumer Products. Municipality of Metropolitan Seattle (METRO), Exchange Building, 821 Second Ave., Seattle, WA 98104. (206) 447-5875. ($4.60 including postage). Four general classes of household toxicants are examined — pesticides, paint products, household cleaners and automotive products. Each product class is examined as to its health effects and environmental impact. Also reviewed are problems associated with use and disposal of the products. Background information and usage figures are also presented. The reader will find a wealth of information in this manual.

CURRICULUM

Aquatic Project WILD. Contact: Cliff Knapp, Lorado Taft Field Campus, Box 299, Oregon, IL 61061. (815) 732-2111. Project WILD is an interdisciplinary program of activities in environmental and conservation education which can be used to supplement curricula K-12. The new Aquatic Education Activity Guide (1987) focuses on water resources and habitats. The activity guide is provided by a network of coordinators throughout the state. The Guide contains 40 activities; six of them are concerned with groundwater quality.

Class Project, Wildlife Federation. Distributed at workshops contact: Chair of Conservation Education, Illinois Wildlife Federation, 123 S. Chicago, Rosville, IL 60963. (217) 748-6365. Loose-leaf note book with background information and project ideas. Posters on energy uses, environmental issues, forest/watershed management, hazardous substances, wetlands and wildlife habitat management are included. Designed to help teachers make environmental education part of the junior high or middle school curriculum. The program encourages classes to initiate environmental projects in their localities and be recognized as part of a nationwide network of conservation classrooms.

4-H Water Quality Program. Contact: Bob Long, State 4-H Office, 1901 University Inn, 302 E. John, Champaign, IL 61820. (217) 333-0910. The 4-H Clubs have developed a series of activities which can be incorporated into school curriculum. Projects include Earth Trek (conservation), Adopt a Stream, and Site Evaluation (survey/testing/analysis/reporting).

Groundwater. Johncock, Kendra S., George Williams College, Resident Outdoor Program, Williams Bay, Wisconsin 53191. Copyright 1987, all rights reserved. Background information and a series of classroom activities designed to be used as a supplement to Lake Studies curriculum. Information helps students understand the concept of groundwater as it relates to movement, the water cycle and our daily lives.

Groundwater: A Vital Resource - Student Activities. Contact: Tennessee Valley Authority, Office of Natural Resources and Economic Development, Environmental/Energy Education Program, Knoxville, Tennessee 37902. (615) 632-6442. Excellent series of activities for grades 3 - 12 including the Water Cycle, Water Distribution in Soils, Water Quality, and Community Impacts on Groundwater. Free.

Groundwater Study Guide. Contact: Environmental Education Specialist, Wisconsin Department of Natural Resources, P.O. Box 7921, Madison, WI 53707. Publication 19-8500 (84). Contains useful background information about groundwater, a lengthy list of suggested activities and a highly detailed illustration of the hydrologic cycle. Activities on the hydrologic cycle and constructing a model water well are outlined in greater detail.

Groundwater Quality Protection in Oakland County; A Sourcebook for Teachers by East Michigan Environmental Action Council ($10 including postage). Intended as a reference source on groundwater quality protection, this manual addresses the water cycle, characteristics and uses of groundwater and dangers of household hazardous materials from a safety and groundwater hazard standpoint. Includes "hands on" projects directed at junior high and middle school science and social studies teachers. Available from: East Michigan Environmental Action Council, One Northfield Plaza, Troy, MI 48098. (313) 879-6040.

OUTLOOK for Groundwater. Contact: Dr. David McCalley, Institute for Environmental Education, McCollum Science Hall, University of Northern Iowa, Cedar Falls, IA 50614. Iowa State University, Cooperative Extension Service, Ames, IA 50011. A series of classroom activities: elementary, middle school/junior high, high school levels. May only be available through participation in week long course.

Sandcastle Moats and Petunia Bed Holes - A Book About Groundwater. Contact: Virginia Water Resources Research Center, 617 N. Main Street, Blacksberg, VA 24060-3397. Well illustrated text with a few interesting demonstrations/activities. Applicable units include: Where's the Groundwater; How Does It Travel; What's in the Groundwater; What We Can Do to Help. Text is intended for junior high level and older. $8 per copy.

Sleuth: Educational Activities on the Disposal of Household Hazardous Waste. Contact: Toxicant Program/HHWD Program, METRO M/S 81, 821 Second Ave, Seattle, WA 98104. (206) 447-5875. $3.60 (includes postage).

Toxics in my Home? You Bet! Contact: Golden Empire Health Planning Center, 2100 21st St., Sacramento, CA 95815. (916) 448-1198. For separate curriculum guides, K-3, 4-6, 7-8, 9-12. Concepts and issues addressed include: emergency preparedness and problems with antidotes, labeling of ingredients, adverse health effects, disposal problems, advertising techniques and safer substitutes. $14 with binder, $10.00 without binder, includes postage.

Toxic Substances In The Environment. This easy-to-read text book provides up-to-date and informative reading material on toxic chemicals. Contains two chapters on chemical hazards around the home. The book discusses the benefits of some chemicals, the problems they can cause, and how we can reduce or avoid their harmful effects. Especially appropriate for junior high and high school ages. Contact: Kendall/Hunt Publishing Company, 2460 Kerper Blvd., Dubuque, IA 52001. $6.31 (includes tax and postage).

WATER: Liquid of Life. IEPA, 2200 Churchill Road, P.O. Box 19276, Springfield, IL 62794-9276. (217) 782-5562. An educational jacket designed for use at fifth grade level. Contains suggested text, experiments, handouts, activities, and posters. Free.

Water Chemistry and Beach Studies 1986. Contact: Shelly Lipowich. Lake County Education Service Center, 19525 W. Washington St., Grayslake, IL (312) 223-3400.

TEACHING AIDS

Chemical Hazards in the Garage and Workshop and Chemical Hazards in the Home. Contact: HWRIC, 1808 Woodfield, Savoy, IL 61874, (217) 333-8941. 11" x 17" posters list hazardous household products, their proper disposal, and alternative materials. (See "Hazardous Homework" activity.)

Groundwater and Agricultural Chemicals: Understanding the Issues. Contact: American Soybean Association, ATTN: Lisa Gleeson, Box 27300, St. Louis, MO 63141. Free rental available in 1/2" VHS, Beta, 3/4", 16mm Film. 17 1/2 minute video/film narrated by Hugh Downs features farmers, researchers, and environmental experts discussing the issue of groundwater contamination.

Groundwater Flow Model. Contact: Chris Mechenich, Central Wisconsin Groundwater Center, 010 Student Services Center, UW- Stevens Point, Stevens Point, WI 54481. (715) 346-4270. $150 plus $8 shipping. Model is 24" long, 12" high, and 1" thick. It is capable of demonstrating at least fourteen groundwater flow principals. Excellent teaching aid.

Illinois Groundwater: Our Invaluable Hidden Resource. Contact: ENR, 325 W. Adams, Springfield, IL 62704-1892. This 20 minute slide set informs viewers of groundwater principles, quantity and quality concerns, provisions of the Illinois Water Use Act of 1983 and IGPA.

The Illinois Groundwater Protection Act: An Overhead Slide Set. Contact: ENR. Provides a series of concept slides and graphics on groundwater, threats to it, and the various provisions of Illinois Groundwater Protection Act (IGPA).

Making the Connection. Contact: The Ecology Center of Ann Arbor, 417 Detroit Street, Ann Arbor, MI 48104. (313) 761-3186. A video presentation for teachers on incorporating household toxics in middle and high school health and science classes. Length: 12 1/2 minutes. "Toxics in My Home? You Bet!" curriculum guide also available (see Curriculum). $2.

Resources for Teaching Geology. Contact: ISGS. Explains materials and services available from the Geological Survey which includes publications, maps, field trips, rock mineral and fossil sets, presentations. Updated periodically. Free.

CONCEPTUAL FRAMEWORK

This framework serves as the conceptual basis for activities in the Groundwater Activities guide. Each activity in the materials is designed to correspond to one or more points in this outline. Sometimes the correspondence is direct; that is, the activity is designed to teach the underlying concepts. In other instances, the relationship is indirect; that is, the reference to the conceptual framework is made to provide additional background information for the instructor.

I. **Awareness of Groundwater**
   - A. Different processes make up the water cycle
   - B. Cyclical nature of water system
   - C. Source of recharge
   - D. Cohesion and gravitational pull of water molecules affect water movement

II. **Diversity in Groundwater Systems**
   - A. Seasonal influences and distributions
   - B. Urban environment versus rural environment recharge ability
   - C. Residence time in a given area
   - D. Subsurface strata influences groundwater movement and availability
   - E. Surface strata influences permeability of water into the groundwater system
   - F. Quantity of groundwater available

III. **Uses of Groundwater**
   - A. Practical application
   - B. Historical perspective

IV. **Contamination of Groundwater**
   - A. Atmospheric contaminants affect groundwater
   - B. Sources of contamination
     1. landfills
     2. improper disposal via shortcut routes
   - C. Where is Away?
   - D. Clean-up techniques

V. **Protection of Groundwater**
   - A. Legislation
     1. Federal Groundwater Act
     2. Illinois Groundwater Protection Act
   - B. Monitoring for pollutants and proper care

VI. **Groundwater as a Human Resource**
   - A. Human understanding of how things work changes over time
   - B. Historical perspective
   - C. Ethics and societal changes

VII. **Responsible Human Action**
   - A. The many things unknown to humans open many opportunities into discovery through research
   - B. Decision-making
     1. personal and as a consumer
     2. economics
     3. risk assessment of products produced and used

Groundwater Education Materials EVALUATION FORM

Name _____

Address _____

City _____ **State**_____ **Zip** _____

Title of Activity _____

1) Please rate the following:	**(1 = Agree, 4 = Strongly Disagree)**
Activity meets the stated objectives.	1 2 3 4
Materials needed for activity are accessible.	1 2 3 4
Procedures are clear.	1 2 3 4
Suggested setting is appropriate.	1 2 3 4
Illustrations are clear.	1 2 3 4
Background information is adequate.	1 2 3 4
Activity worked well for suggested group size.	1 2 3 4
Student involvement was maximized.	1 2 3 4
Students responded enthusiastically and are interested overall.	1 2 3 4
Activity is applicable to present curriculum.	1 2 3 4
Activity is a valuable supplement to present curriculum.	1 2 3 4

2) Suggested time to implement activity is:

(circle one) too long adequate too short

3) I tried this activity with _____ _____
(# of students) (grade level)

4) Comments:

Please return to: Illinois Department of Energy and Natural Resources, Groundwater Education, 325 W. Adams Springfield, IL 62704-1892.